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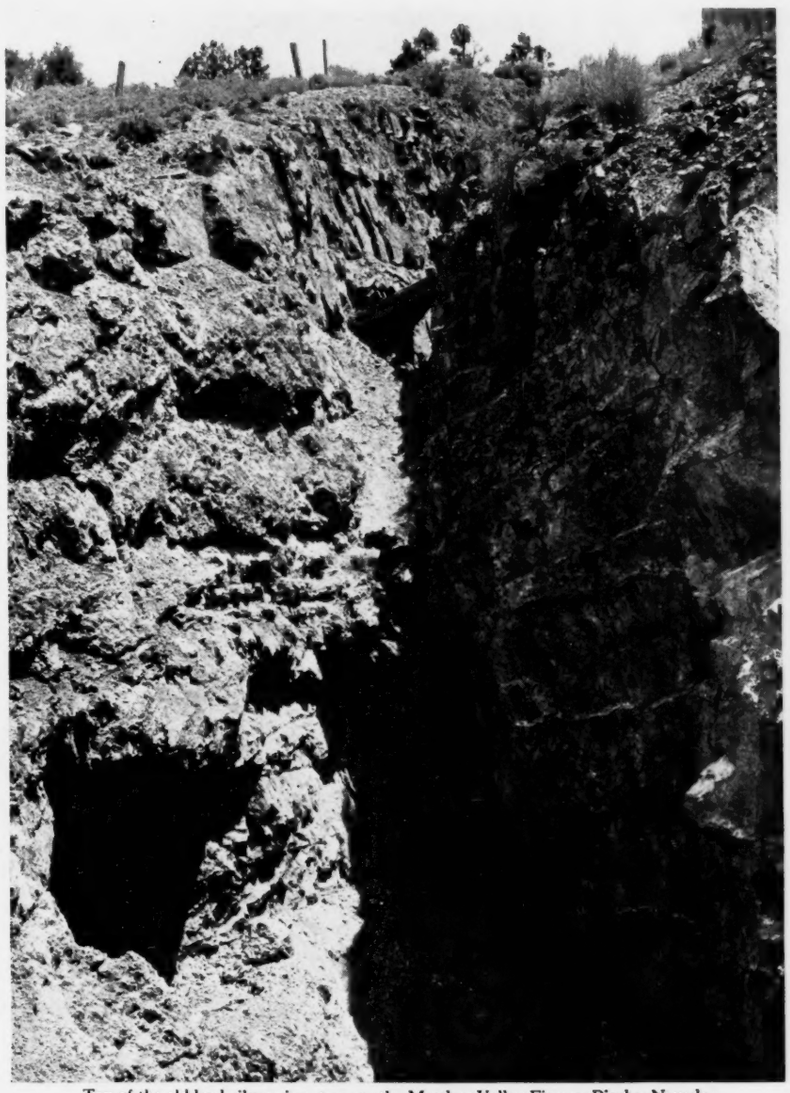
ENGINEERING AND MINING JOURNAL



Top of the old lead-silver-zinc stope on the Meadow Valley Fissure, Pioche, Nevada. A clean-cut fissure vein in quartzite mined to a depth of 1,200 feet.

Chloridizing Roasting is an ancient metallurgical process, but only comparatively recently have the possibilities of making volatilization a major feature of the process been recognized. The idea is now being actively developed. In this issue Thomas Varley offers critical comments on some recent work.

Ore Deposits of the Pioche District, Nevada, *by John Carter Anderson*
Roasting Zinc Ores for Electrolytic Reduction, *by Thomas French*
Australian Mining Conditions, *by Peter G. Tait*

Biography of Frank Klepetko

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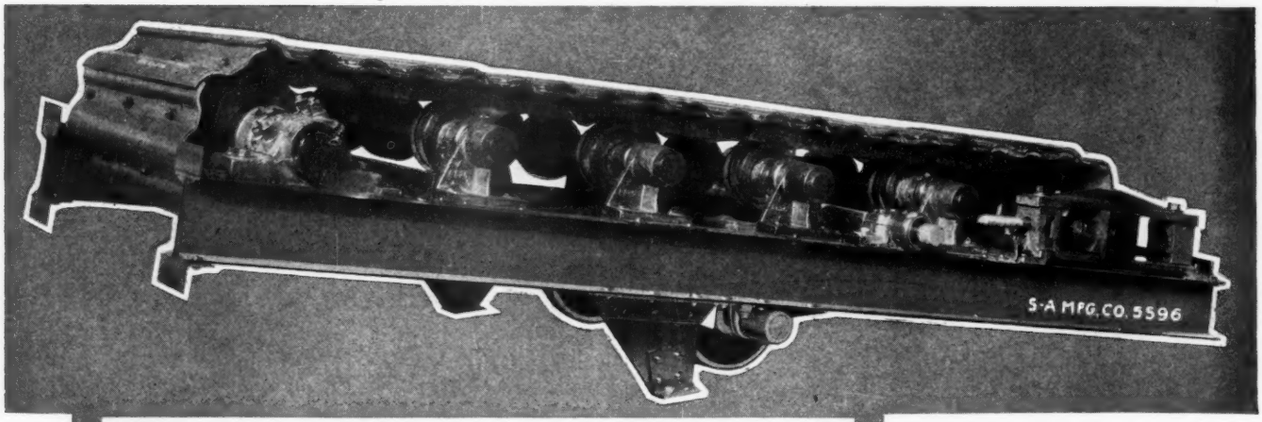

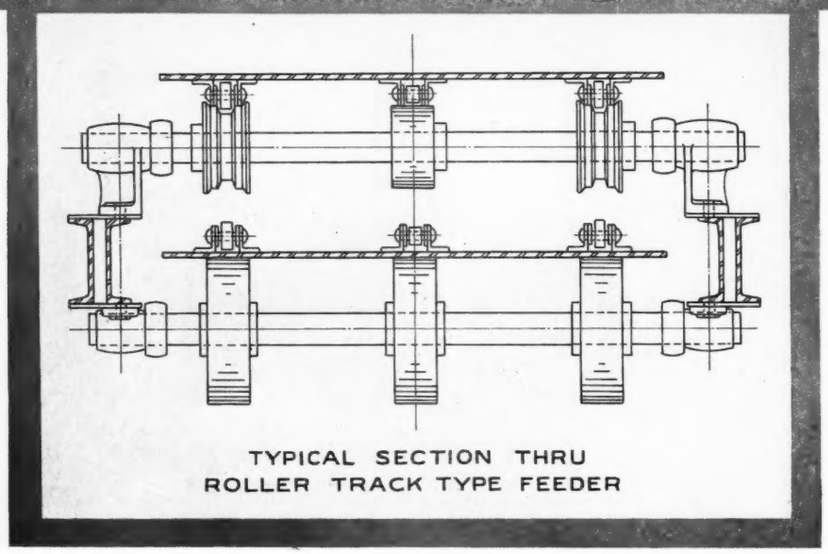

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Volume 113 **New York, February 18, 1922** *Number* 7

The Resumption of Copper Production

RESUMPTION OF OPERATIONS by some of the copper mining and smelting companies, and rumors of early activity at others, have come at a rather unfortunate time, for the last buying movement ended in December and the next has so far shown no signs of appearing. The result of expected increased production and an oversold market has been a price depression to a point almost a cent under the high figure of 13⅞c., delivered, which was reached in the last half of December. The London market has also weakened, owing to lack of local demand and pessimistic ideas of European copper requirements. Doubtless the weakness in both the London and New York markets has been to some extent interrelated.

Large amounts of copper were sold for both domestic and foreign deliveries during the last four months of 1921. This is gradually being used up, and buying for spring and summer requirements should begin in the next few weeks. This will quickly stiffen the price, both because a great amount of the metal is not available at current low prices, and for the reason that when consumers see that the low point has been passed they will be anxious to buy before any material advance has occurred. It is significant that all of the larger producers are firm in their disinclination to sell at the lower prices of the last few weeks. They will be able to obtain their price if they have sufficient staying powers, which it is altogether likely they have. It is equally significant that astute metal-trading interests are willing to sell for deliveries to the end of 1922 at or less than 14c., delivered. It is evidently the expectation, therefore, that prices throughout the year will not vary greatly from the 14c. level.

The worst thing that can happen to the copper market is too great a haste to resume producing operations, and to conduct them on too extensive a scale. It is natural that the various companies should wish to end the period of forced inactivity at the earliest possible time, both to promote the welfare of their former employees and also to have a better choice of men for their operating staffs. However, there is no surer way to depress prices and to duplicate the conditions which existed in 1920 and the early months of 1921 than to keep production two or three jumps ahead of the demand. Further delay in resuming may seem onerous, but it will result in more prosperity when the time comes.

The managements of the porphyry coppers, and they are generally large producers, disclaim any intention of resumption until conditions materially change. We think they are exceedingly well advised, and that they deserve the thanks of other producers for adopting this attitude. A price of 13 or 14c. was not an altogether unprofitably one for copper producers before the war, but it will be some time, we venture to say, before wages and the cost of supplies and transportation will reach the old levels.

The Arms Conference

THE ARMS CONFERENCE at Washington will, we feel sure, be recognized in history as one of the great forward steps which the world has taken. It has been successful past all our expectations and hope. The dramatic stroke at the beginning of the conference, of limiting the naval strength of the principal sea-powers, and thus for the first time in the world's history putting a stop to the race for naval superiority, at once placed the conference in a new category as regards diplomatic methods and swift accomplishment. The various discussions and differences since then have rather wearied a fickle, sensation-loving public, and the failure to agree upon submarine, aircraft, and land forces limitations has rather dampened the thunder of applause from the on-looking gallery.

The agreement upon international rules against using submarines to attack merchant vessels and against the use of poison gas sounds well, and is possibly well as far as it goes; but is not efficient war, such as the Germans prosecuted, of the kind that profits by broken rules? War is treachery and murder at best. Small use, then, for France to forsake poison gas, unless Germany does; and if Germany does, the indications are that she doesn't, but that in deep cellars and behind the walls of factories preparations go on as of old. The saner policy for France and the United States would be to trust in agreements, but keep their poison gas handy.

Nevertheless, the conference has been a great success; if it should be continued by others as fruitful, the halcyon days of the world may have begun. The crowning achievement was the complete settlement of the Chinese-Japanese-American question, by the return by Japan of Shantung to China, and the withdrawal of all foreign aggression and territorial aggrandisement from China. Add to this the Pacific four-power treaty, and we see peace in the Pacific assured beyond much doubt for at least ten years. More than that, a new standard of fair and even generous dealing between nations has been set.

Of great importance has been the faith and confidence of other nations, European and Asiatic, in the motives of the United States and a willingness to subscribe to her program, because it was the happiest way out. England's firm friendship and constant co-operation have made the thing possible.

Of deep significance are the words of Baron Kato:

> "In Japan we realized that a new spirit of moral consciousness had come over the world, but we could not bring ourselves truly to believe that it had struck so deeply into the souls of men until we came to Washington. We came and we have learned; and in turn we have, I think, given evidence such as no man can mistake that Japan is ready for the new order of thought—the spirit of international friendship and co-operation for the greater good of humanity—which the conference has brought about."

Much is left unsettled: but when we consider what has been done, we take heart and joyfully applaud.

Culture vs. Technique

IN A RECENT QUESTIONNAIRE circulated by the Mining and Metallurgical Society of America the following question is asked:

"In the planning of a course for the training of mining engineers, should the object be to turn out men trained along broad cultural lines, and with a thorough groundwork in the fundamentals of engineering, or is the object desired to turn out men trained in the technique of the profession and more along vocational lines?"

The question depends for its answer primarily upon the type of ability represented by the student. If he has ability, brain power, initiative, and imagination he should pass through the groove of "a thorough groundwork in the fundamentals of engineering." "Broad culture" is not the function of the engineering colleges, but of the colleges of arts, and the student who desires this training may acquire it there. If he has only a few strings to his bow, then he should narrow his objective by concentrating on one or at best a few subjects which should have technique as the foundation and a presentation along a vocational trend. The inherent ability of the student is the determining factor in the attaining of a specific objective. The objective should harmonize with the average student's abilities.

Another question covers the time to be given to instruction and is as follows:

"Most of the mining schools of the country offer a four-year course in mining engineering. Columbia and Stanford require six years, and Harvard has a five-year course. The Michigan College of Mines completes the course in three years, the number of weeks' work being, however, approximately the same as in the four-year courses of other schools.

"Question: What, in your opinion, should be the length of course?"

Before this question can be answered adequately we must know whether the mining schools are making efficient use of the time allotted to them. Is there sufficient concentration upon primary objectives? Are there not too many amusement and athletic diversions that militate against concentration? Are there not too many interruptions to continuous effort by short terms, interims, holidays, and excessive dissection of subjects?

Michigan outlines a course and allots three years to it, permitting the student who cannot keep up with the pace to take a longer time. In the four-year courses which cover approximately the same ground as Michigan does the pace must be too slow for some students. What about the pace in the five- and six-year courses? Recently a student came into our office and stated that he was quitting his course, a six-year one, because the sixth year offered so little that he could not see how he could keep himself busy. It is our candid opinion that with efficient use of the time and a well-planned curriculum, four years would be sufficient for students of average ability. By skillful arrangement of the curriculum, the student of less aptitude could extend his time to five years.

In addition, the objectives of the course play a part. If men are to be trained for service positions, two years efficiently used might be sufficient. Thorough training for an engineering career might require four or five years. This brings us back to the questions of what we mean by an engineer and what fundamentals of training are necessary to approach this definition. Thus it becomes highly important for mining schools accurately to define their objective and to plan for an efficient use of time.

International Taxes

WE AS A NATION are heavily taxed. Much of the tax goes to pay interest on war loans, and out of these war loans, billions went to our European allies as loans. On this we are getting no interest, so that the interest on the bonds bought by the American nation is not paid by the ultimate foreign borrower, but by the American taxpayer, who happens to be the bond buyer also. He digs up the taxes and pays himself the interest via the U. S. Treasury.

"But," says France, our largest creditor, "Germany owes us more than we owe you. Russia owes us as much. Yet the tendency of your philosophy is to call Russia a bankrupt and let Germany beg off the same way, but to hold us to our debt. Very well: we will pay our debt—if and when Germany pays us. Otherwise we shall owe you honorably forever." Says the editor of *Le Matin*, "France owes it, and she will never stop saying that she will pay"—a dry prospect, certainly.

It is all logical: the trouble is that the United States does not owe anybody else; otherwise her taxpayers might be as cheerful about mutual cancellations as are those of some of our European allies. England will cancel France's debt to her if we cancel the English debt: France will cancel part of the German debt if England will cancel her bill against France and we will do likewise. It is a simple arithmetical problem in cancellation. But for us, it would look bad on the books, even though it might mean our cancelling what we do not have and have a fat chance to get. So we shall wait to see what turns up at the Economic Conference in Genoa: after which it is plain that we shall receive a letter from across the water. But if it becomes clear to us that our taxpayers' prospect of the burden being slightly lifted depends ultimately partly upon the fulfillment by Germany of her reparation payment to France, and of Russia being set up in business under a guardian and made to pay her just debts, then maybe as a sentimental people we shall not be quite so sympathetic with the theories of those countries (like Germany and Russia) that they should pay nothing, and not so indignant about the American capitalist being eager to get back from those countries what he has loaned. *"L'état, c'est moi,"* said Louis XIV—"the state, it is I!" *Eh bien!* The capitalist, it is ourselves—the taxpayers—in the present instance.

Concerning Mining Books and Mining Journals

BOOKS AND JOURNALS take the place, if need be, of instructors, companions, and next friends. Many a mining man in a remote camp turns of a winter night to his shelf of favorite authors, his little library of technical volumes which discuss the problems of his own profession, his favorite literary and technical journals.

"Oh, that mine enemy would write a book!" was the pious prayer of an ill-wisher, knowing that the solemn and silent one may gain a great reputation for wisdom, but if he shows his hand, or, more properly speaking, his head, he at once exposes shortcomings which brand him as a poor weak one among mortals. And if the man that writes a book gambles and plays possibly a losing game with his prestige, how much more reckless an adventurer is he that writes and prints, every week, editorials, for fifty-two weeks of the year! The letters which we get from our interested readers, some pounding out the fact that we have displayed ourselves as poor,

ignorant, dumb fish, others extolling us as almost worthy to be ranked among the foremost thinkers, show the danger of the fray and the audacity of the business. But when we have encountered a book of ours in the scanty pack of a tramper in the jungles of Nicaragua or treasured in the library of a lonely and thoughtful man in Mexico, or find that our little lessons are being taught to students in South America; or when our book has won us a hearty handshake from a prospector in Nevada, we have come to believe that the game is worth the candle and that we will take the danger of incidental missiles.

But each man covers in his mental scope only a small segment of the field of technical knowledge. The scope of the mining field has become so great that specialties unsurmountable arise. You may be expert on flotation; what do you know about blasting? You are a successful mine manager; what do you know about geology? Better possibly that you forget what you think you know if your thought runs in that direction. You understand about hoists and compressors and the like, even kilowatt-hours and power plants; do you understand the domestic and foreign situation of the market for the metal you mine? No, you do not know it all; the all-round mining man who protested his universal knowledge twenty years ago has shrunk into the background. He is likely not to know enough about anything to be able to compete with specialists; and jobs for him turn out to be increasingly scarce. But you can know as much about one branch as anybody—more than anybody should be your ambition; and when you want the details of the other branches of which you have only a general knowledge, you can look it up. You can ask those friends on your bookshelf, who have concentrated on the matter, till they are willing to gamble their reputation that what they say is correct.

You cannot do everything in your plant, even if you are general manager; many of your subordinates or your operating staff know more about some one detail of the business than you do. But by marshalling and controlling their knowledge and skill you extend the range of your own powers. Your books and journals are your technical staff. You have here your assistants, your specialists on mine management, cyaniding, flotation, concentration, power plants, electric installation, breaking and stoping, geology, market situation. They are ready when you want them—and this is the justification for editors and publishers, for without them the progressive evolution and improvement of the business of mining could not go forward.

The Printer's Devil

IN OUR Annual Progress Number of Jan. 21, the imp that lurks in type and printer's ink made Mr. Sidney J. Jennings say, referring to Canada and India:

"It seems inevitable that a decrease in gold production in these two countries must take place, *in the cost of supplies and labor which took place during* may hold out surprises in the direction of new production."

This evidently unintelligible sentence was due to the error of an entirely foreign line being inserted in the paragraph, instead of the one in which a typographical error had been marked by the proofreader—all text pages of the *Journal* being set in linotype "slugs." What Mr. Jennings actually wrote was:

"It seems inevitable that a decrease in gold production in these two countries must take place, *although Canada, with its large area still unexplored,* may hold out surprises in the direction of new production."

Certainly no line could have been omitted with more ingenuity to obscure the real intent of the analysis, with the accuracy of which all will agree.

Mr. W. R. Rogers, statistician of the Department of Mines at Toronto, in commenting on this subject, writes as follows:

"It is true that Canada's annual output of gold during the years 1917 to 1920 inclusive fell short of the output for the preceding quadrennium. This was due to war-time conditions and the readjustment period which followed. There is every indication that gold production is on the upgrade for the next few years at least. The output from placer mining in the Yukon and British Columbia is on the decline, but this is more than offset by the increase from lode mines in other parts of Canada, notably the Province of Ontario. The production of Canada is important and is now equal to 30 per cent of that of the United States.

"Porcupine, Ontario's greatest gold camp, first became an important producer in 1912, and that year Ontario contributed only 14.1 per cent of Canada's total gold output. This percentage has steadily increased, until in 1920, 73.9 per cent, or $11,665,797 of Canada's gold production, came from Ontario. Ontario's gold output in 1921 is estimated at $13,870,000, without the exchange premium, which will average about 10 per cent. In 1922, production should show an increase of at least 25 per cent over 1921.

"Porcupine has produced annually since 1912 from 89 to 95 per cent of Ontario's gold. Although the stoping levels at the Hollinger, McIntyre, and Dome (the three big producers) have reached depths of 1,530, 1,500 and 1,300 ft., respectively, practically no ore has yet been milled from below the 1,200 level. The McIntyre shaft within a few weeks will reach a depth of 2,000 ft. The grade of the Dome ore now being mined at the lower levels has considerably raised mill heads. In 1921, Dome produced $2,290,000 from ore yielding $6.82 per ton. Hollinger, during the month of December, treated an average of 3,900 tons daily, and mill heads during the first nine months of 1921 averaged $8.55 per ton. The objective for this mine is 7,000 tons' daily capacity. Dome capacity is approximately 1,100 tons per day, and McIntyre is being increased from 550 to 800 tons daily.

"At Kirkland Lake, where some very high-grade ore is being milled, it is expected that six producers in 1922 will turn out about $3,000,000 in gold. In this camp practically all the ore is being developed above the 600 level, except at the Kirkland Lake mine, where the main development is between the 700 and 900 levels. The Lake Shore mill in December treated about 65 tons of high-grade ore daily, averaging $35.35 per ton, the best performance on record to date.

"There are several other promising gold-mining areas in Ontario in the development stage. The same applies to the Province of Manitoba. In fact, lode gold mining in Ontario is the brightest spot in the whole mineral industry of Canada."

Canada possesses an immense unexplored territory where the prospect of finding new mines is excellent. Our news columns recently reported a rush to a new gold strike in The Pas district. Whether or not this turns out to be of importance, it would indeed be strange if many new ore deposits of gold, copper, and other metals are not eventually opened in this northern area, as the country is slowly searched by prospectors. It is only comparatively recently that the construction of two new transcontinental railroads has opened up vast new territories to easier prospecting. And away from the railroads, particularly to the north and east of the Porcupine district, is an enormous district rich in possibilities. Quite recently a man wrote in to us and asked an indication of where he might prospect. We suggested Canada.

WHAT OTHERS THINK

Chloride Volatilization

Thomas Varley, of the U. S. Bureau of Mines,
Comments on H. R. Layng's Article
in the Nov. 12th Issue

THE DISCUSSION of chloride volatilization by Mr. Layng brings up many points of interest. The general summation of the article presented by him indicates that all his experiments, with the exception of the one made in the semi-commercial plant, were conducted in small muffle furnaces. Evidently the object of Mr. Layng's publication is to protect certain features set forth as possible bases for patent issues.

CRITICISM OF ROTARY FURNACE

Mr. Layng first states that "in most chloridizing volatilization work, the ore and chloridizer are fed into a revolving furnace fired at the discharge end." This is somewhat misleading, for at the Salt Lake Station of the Bureau of Mines, where work has been carried on for the last four years on this process, the experiments and research tests conducted have been made in practically every kind of furnace and under varying conditions. The rotary kiln, adapted after the cement type of furnace, has been generally used for the larger tests, for the reason that the mechanical difficulties in large-scale operations by this kiln are few.

Mr. Layng emphasizes, and no doubt rightly, the rôle of rapid heating, though it is probably more accurate to say that recoveries are dependent upon the kind and amount of chloridizing atmosphere, the latter being obviously dependent in part upon the rate and the manner of heating. This is a rather self-evident statement, the truth of which has been frequently commented upon by other investigators. The fact that revolving kilns have been designed and operated for long periods of time with scoop feeds in which the ore and chloridizing reagents have been fed immediately into the heated end of the kiln, and passed through the furnace to the discharge end, is substantial evidence that the subject of rapid as against slow heating has been under practical test on a large scale. This is also true of the plant at Harbor City, Cal., designed by Morris P. Kirk and E. P. Barrett, in which they tilted the larger furnace with the intake of the feed at the hot or fire end of the furnace. G. H. Wigton, of the Chief Consolidated Mine, at Eureka, Utah, also has installed a similar kiln.

SUPPLY AND DISSIPATION OF CHLORIDIZING AGENTS

The varying rate of expulsion of the chloridizing agent in different kinds of ore has been noted by numerous experimenters, and devices have been made and used for feeding the chloridizing agent directly into the heated zone of the furnace, and independently of the ore. The actual rate at which the chlorine or its compounds is eliminated from the ore seems to depend not only on the chemical nature of the ore (acidic or basic) but also on the physical conditions of the ore particles themselves, as the rate of evaporation is a direct function of the surface exposed, except in relation to adsorbed films.

This is a natural conclusion and is set forth clearly in Serial No. 2,247, *Reports of Investigations*, Bureau of Mines, May, 1921, by Thomas Varley and C. C. Stevenson. This paper explains the dissipation of chlorides and the addition of calcium chloride in a specially designed injector at the heated portion of the kiln. In February, 1919, calcium chloride was added by this injector to the heated portion of the 50-ft. kiln at Goodsprings, Nev., and was also supplied in a similar manner in solution form.

POSSIBILITY OF ERRORS IN MUFFLE TESTING

The usual experience with muffle tests on the chloride volatilization process indicates that it is extremely difficult to draw rigorous conclusions from results so obtained. This is particularly true when one is attempting to compare recoveries (i.e., amounts of various constituents volatilized) in related experiments. Even the matter of small inaccuracies in temperature determination is often sufficient cause for considerable discrepancy between otherwise comparable experiments. For example, it is perfectly possible that a temperature difference of 100 deg. between two tests might cause a difference in silver recovery, say at 850 and 950 deg., of no less than 50 per cent. As a safe estimate of the accuracy of technical temperature measurements at or near 1,000 deg. C. should allow for a variation of from 10 to 20 deg., two apparently duplicate tests might readily vary by $\frac{20}{100} \times 0.50 = 10$ per cent from this cause alone. In view of the possible discrepancy from undetermined causes, Mr. Layng's conclusions, based on runs *A* and *B*, second paragraph, page 766, and in all other instances where he places reliance on muffle tests, seem to be without sufficient warrant. Judging from our own experiences, it is probable that duplicate tests, made under conditions as nearly identical as they can be controlled in a muffle, might be subject to even greater variations than those observed.

Although muffle tests of the sort described are sometimes useful in a roughly qualitative way, the nature of the exact chemical reactions taking place during chloride volatilization is not determinable by these methods. Our knowledge of the complex reactions, a number of which probably occur simultaneously, is admittedly incomplete, and we therefore feel strongly that exact knowledge of what is taking place can be had only from scientific research rather than from small-scale technical experiments.

PHYSICAL AND CHEMICAL COMPOSITION OF THE ORE AS FACTORS AFFECTING VOLATILIZATION

Microscopic examination of coarse calcined materials has shown the presence of mineral particles which had not been noticeably affected by the treatment received, and this evidence indicates that grains of mineralized quartz do not necessarily crack and expose the incased mineral to volatilizing conditions at the temperatures attained.

Ocherous oxidized ores are nearly always more porous and disintegrated than a straight siliceous oxidized ore, and the larger surfaces and nature of the first-named material would help to prevent vaporization loss of a chloridizing agent. Judging from the sulphur analyses, Mr. Layng was dealing only with oxidized ores—the type that have the greatest chance for success by volatilization, from the economic viewpoint, considering the difficulties found with other processes.

It will be noted that Mr. Layng, in common with other experimenters, has found considerable difficulty with silver. Beside the above-noted physical factors of manner of dissemination of the metallic portions, and the porosity of the ore, the actual constituents present in the gangue and the properties of the metal chloride itself must be examined. From work done in chloridizing processes (cf. O. Hofmann, "Hydrometallurgy of Silver") and in other processes where it was attempted to chloridize and volatilize the base metals, leaving behind metallic gold and silver (Schnabel, "Handbook of Metallurgy," "Chloridizing Roasting of Silver Ores for Amalgamation"; Rose, "Metallurgy of Gold," page 414, "Miller's Chlorine Process"), it was found that silver chloride formed largely after the other base-metal chlorides, and volatilized with greater difficulty. This, in connection with the above set forth statements on the varying physical natures of ores, and in consideration of the fact that silver is not only finely disseminated but also very low in percentage, would account for the difficulties found in volatilizing this metal without bringing in any unusual chemical compounds.

Some unpublished work on chloridizing of silver minerals, done at the Pacific Station of the Bureau of Mines, has shown that most of the silver minerals during oxidizing roasting are converted to metallic silver and likewise under certain conditions the chloride of silver tends to decompose and give metallic silver. We find metallic silver difficult and rather slow to chlorinate, and are now working on the hypothesis that the formation of metallic silver is one of the chief contributors to the above-mentioned trouble.

The Causes of Sintering and "Balling"

The causes of sintering and "balling" in a kiln, with methods for their prevention; the importance of having the chloridizing agent present at the point of maximum temperature, together with the conditions preventing that presence and means to overcome the difficulty; firing at the feed end of the kiln, and the importance of a high temperature for rapid volatilization, were all noted in articles published before, particularly in one appearing in the Bureau of Mines Report, Serial No. 2,247 (Varley and Stevenson), May, 1921. Mr. Layng's work confirms many of these points. Perhaps he has over-emphasized the influence, in "balling," of a great excess of chloridizing agent, as compared to the influence exercised by the constituents of the ore. The melting point of salt, for instance, is given as 804 deg. C. Unless a great excess of salt has been used, the greatest "balling" is at the hottest zone (say 1,000 deg. C.), with the lead and other compounds in the charge exercising great influence. The use of lime, feeding the chloridizing agent in at the hot zone, and other methods of procedure, have been noted in the article above mentioned and in others. It may be noted that Mr. Layng's ore No. 5, with only a "trace" of lead, "showed the least tendency to cement," whereas ore No. 1, containing 6.37 per cent lead, and only 0.83 per cent lime, showed the greatest.

Mr. Layng confirms the fact, already noted, that calcium chloride is a better volatilization agent than sodium chloride, and also is better to prevent "balling." The distinction between this "balling" and a truly sintered product should be carefully noted—provided "balling" is not excessive it will often give a calcine lower in metal content than the rest of the product, and it will tend to prevent "dusting." The sintering caused by forming, say, lead silicate, will be very harmful, and when large pieces of this sinter must be barred from the hottest zone, tailing losses are usually high. It is also true that most metals evaporate as such with much less speed than as chlorides.

Besides the varying degrees of fusibility given to an ore by its gangue constituents, these latter, even not including the well-known reactions of sulphur compounds, may be of importance from the chloridizing standpoint. For instance, writers have accredited much importance to manganese dioxide and cupric oxide. There is still much work to be done on determining the effect of the presence of various gangue constituents on chloridizing reactions.

Mr. Layng's Furnace an Ingenious Development

Mr. Layng's furnace contains many ingenious ideas, and it is to be regretted that more data showing the results from its operation have not been submitted. The method of assisting the dust to settle and of obtaining a high hydrochloric-acid concentration to assist volatilization should be particularly noted.

The furnace resembles closely the Stetefeldt furnace which was used in the chloridizing roasting of silver ores for many years. Among the articles on this furnace might be quoted one from the *Transactions* of the A.I.M.E., Vol. 25, p. 137, by W. S. Morse, on operation at Aspen, Col. The ore was dried in four double-shelf dryers before being charged into one Stetefeldt chloridizing furnace, all firing being done with producer gas. About 30,000 tons of ore was treated in fourteen months; assuming steady operation, this would indicate about seventy tons' capacity per day. In dropping down the shaft, the sulphur was ignited (possibly the chloridizing action was started), and after the ore was drawn from the hopper at the bottom of the shaft (time in hopper not stated; probably, from other furnace operation, three hours) it was, in the particular case quoted, 43.5 per cent chloridized. Then it was left in a heap on the floor 102 hours longer, at the end of which time a further 26.4 per cent of the silver was chloridized. Of the total ore, 53.3 per cent went down the shaft, and the rest was caught in the return flue and dust chambers, from which it was removed and piled in a heap on the cooling floor. It is not stated how often the flues were cleaned. The ore from the flues and dust chambers was about 20 per cent better chloridized than the ore from the bottom of the shaft. The Aspen plant was, of course, seeking to avoid volatilization loss, as chloridizing and leaching was being practiced. The total loss (mechanical "dusting" and volatilization) is given as about 9.2 per cent. The ore from the dust chambers ran 18 oz. in silver and the ore from the shaft of the furnace 27 oz., so it appears that little volatilized silver chloride was stopped in the dust chambers, and that, therefore, the total amount of silver volatilized was (speaking from the volatilization process standpoint) low. To recapitulate, the

"dusting" was high, the rate of roasting was slow, and the amount lost by volatilization was small.

Mr. Layng will undoubtedly run his furnace at higher temperatures than those used in the Stetefeldt, but some of the difficulties noted would probably be inherent in this type of furnace. It is difficult to conjecture what temperatures were used in the Stetefeldt furnace, as the subject of temperature measurement in those days had received only limited attention and was not well developed.

In new-type furnace operation, it is usually difficult to control, by variation of the fuel, more than one variable. Considering the ore feed fixed, that variable which it is most desired to regulate is the condition of the products—the concentrate and the reject (including slag). It is usually found advisable, to get a good fuel economy, to utilize whatever variable excess heat may come off for some other purpose, as pre-heating the ore or heating steam boilers. However, if Mr. Layng has succeeded in thoroughly volatilizing his valuable metals and at the same time has an exit gas temperature of 300 deg. F., he has shown that he has a most efficient furnace.

The use of a Stetefeldt type furnace had been considered by Bureau of Mines metallurgists, but it had been thought necessary to use the heat of the exit gases through a fairly long covered flue to pre-heat the ore—i.e., using the flue like a muffle for the gas, and rabbling the ore forward; and to evaporate there the excess of liquid chloridizing agent (in any leaching process the chloridizer would be returned as a solution). It was planned to add only enough liquid chloridizing agent to settle the dust.

It was feared that ore charged cold and wet would not have time to be heated to volatilization temperature. Even with these precautions, it was thought that the heat utilization would be poor and the dust loss (and therefore the circulating load) high. If Mr. Layng, in surmounting these difficulties, as he claims he does, has still succeeded in keeping a good extraction, he has originated a remarkable furnace. His estimated costs, as given for a 100-ton plant, are also unusually low. The development of this furnace will be watched with greatest interest.

That Mr. Layng could recover his volatilized product in solution towers would show that he had a different product than Mr. Croasdale, who did not have such success. He possibly had normal chlorides, due to the action of the water vapor, and was thus enabled to absorb them in towers as did Ottokar Hofmann (see Greenawalt's "Hydrometallurgy of Copper," page 238).

Salt Lake City, Utah. THOMAS VARLEY,
Superintendent, Salt Lake City Station,
U. S. Bureau of Mines.

The Calculation of Mill Tonnages

Fred M. Heidelberg, in his article "The Santa Barbara 500-Ton Mill for Concentrating Lead Carbonate Ores," in *Engineering and Mining Journal*, Dec. 31, 1921, calls special attention to the method used to obtain tonnages in the fine-grinding department. These tonnages can also be obtained by (1) simple inspection, (2) a short calculation.

(1)—The total original feed of plus 2 mm. to the rod mill is 425 tons (40 per cent of feed to the trommels, 200 tons, and 75 per cent of feed to the screens, 225 tons). At any instant the rod mill is crushing to minus 2 mm. at the rate of 425 tons. In the mill discharge this represents 50 per cent of the total. Therefore, the load in the mill—original feed plus return—is $\frac{425}{0.50}$, or 850 tons. Add to this the middling return from the tables, twenty-five tons, and the total is 875 tons.

(2)—Let x = the tons returned to the mill from the screens. Then $(200 + x)$ = tons mill load, and $[300 + (200 + x)]$ = tons feed to screens.

As the mill discharge carries 50 per cent plus 2 mm., and the original screen feed 75 per cent plus 2 mm, $0.50\ (200 + x) + 0.75\ (300) = x$, solving which, $x = 650$ tons.

The total load on the mill then, is $x + 200$ or 850 tons. Add twenty-five tons middling return from the tables, and the total is 875 tons.

The circulating load in the mill, due to the return of part of the original feed, is therefore, $650 - (0.75 \times 300)$, = 425 tons.

The ratio of circulating load to original feed is $\frac{425}{425}$, or 1 to 1. This ratio would probably be increased, due to minus 2-mm. material returning from the trommels and screens. GEORGE O. DESHLER.

Butte, Mont.

Direct Advertising for Copper

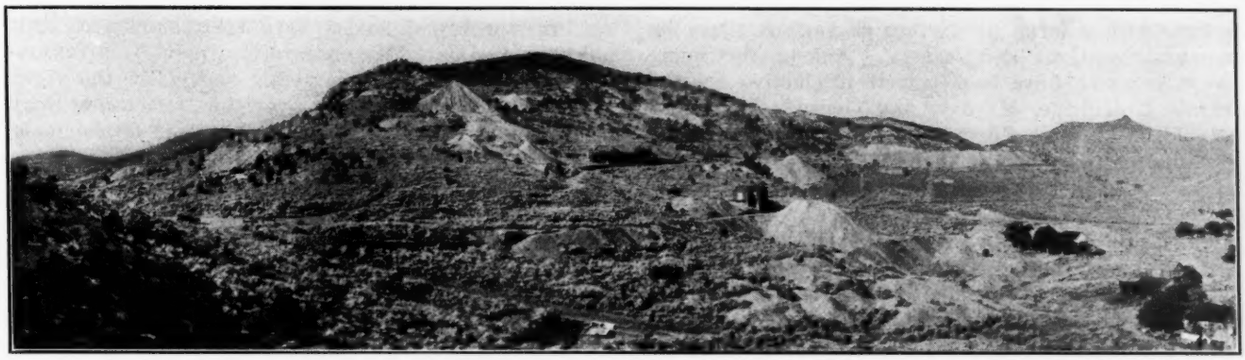
In common with all owners of copper stock, I am interested in improving the position of this metal with the consumer, for the remedy in the present lamentable position of copper seems to me to lie in improving the demand more than in any other direction. I notice that this seems to be the opinion, also, of Mr. A. G. McGregor in the able article contributed to your issue of Jan. 21. The defects in the retail distribution of the metal have been pointed out in various editorial articles. The remedy lies in finding new markets by direct methods.

My own experience in advertising leads me to value most highly the direct, personal appeal, and the experience of other interests in introducing the then new metal, aluminum, points the way. Most of your readers know that this was done by organizing a band of college students under good leadership to visit the housewives of America during the college vacation time and present for their inspection one or more articles made of the new metal. Among these was a lighter tea kettle. The long-suffering drudge who for years had lugged the heavy cast-iron monstrosity from stove to sink and back saw the point at once, and numerous and profitable orders were the immediate result.

This experiment might readily be duplicated in the campaign to popularize the increased use of copper. Aluminum is today the best advertised metal in America, largely because of this campaign, which went direct from the producer to the ultimate consumer. You see comparatively little advertising of the virtues of aluminum, but in every department store you will find a full supply and a vigorous demand.

Without any such demand wash-boiler bottoms are made of copper and many wash boilers are made entirely of copper. The number of small articles used by the housewife and made of copper is now quite limited because of defective marketing, but the number that might be used as the result of well-directed advertising is very large. EDWARD HART.

Easton, Pa.



VIEW OF OLD QUARTZITE HILL IN PIOCHE, SITE OF THE RAYMOND & ELY, MEADOW VALLEY, YUBA AND OTHER GREAT MINES OF THE EARLY DAYS.

Ore Deposits of the Pioche District, Nevada

Failure of Past Development Due to Lack of Correlation of Several Types of Ore Formations—The Possibilities of Following Them From One to Another—Deeper Development, Properly Carried Out, Will Indicate Future Prospects of the Area

BY JOHN CARTER ANDERSON
Written for *Engineering and Mining Journal*

DURING THE SUMMER OF 1921 I spent a number of weeks in examination of mines and prospects in the mining districts surrounding Pioche, Lincoln County, Nev., in the course of which, through the uniform kindness of the residents and operators of the district, I had opportunity to visit nearly every property of interest. Over forty mines and prospects were visited, and many of them studied in detail.

This paper is submitted, therefore, in the hope that it may be of service to the operators of the district, whose many courtesies made it possible, and of interest to others who are concerned with the study of ore deposits.

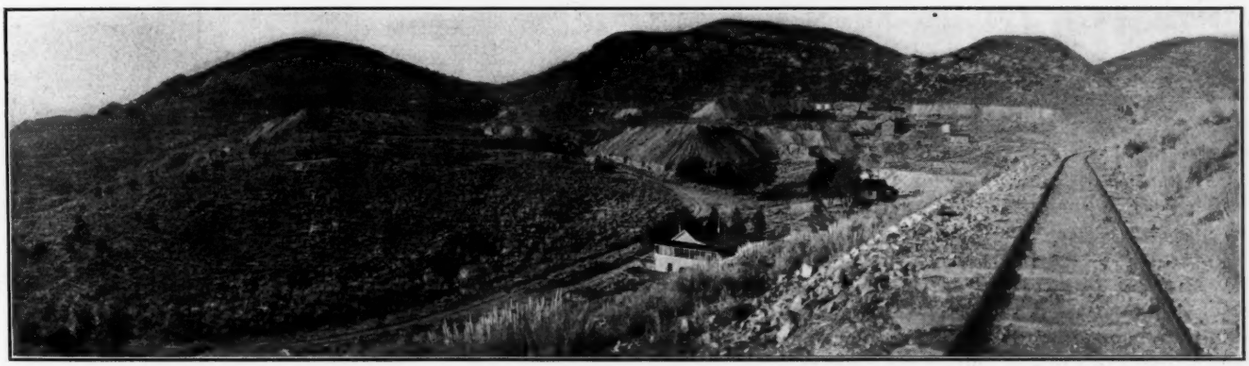
The early discoveries were in the fissure in the quartzite hill south of Pioche, and from 1869 to 1875 there was a production in excess of $16,000,000, principally from the Raymond and Ely and Meadow Valley mines, with some production from the Alps and others. The Raymond and Ely fissure was opened to 1,200 ft. with a winze 300 ft. deeper on the Yuba dike contact, first cut in a crosscut south on the 1,200 level. Decreasing silver values in the fissures, a flow of water on the 1,200 level, and the finding of zinc on the dike contact shut down the mines.

About 1890 another period of activity resulted in the mining of some rich contact orebodies along the Yuba dike in the main camp. In 1907 and 1908 a stock boom of considerable proportions started some operations by a number of companies, of which the Prince Consolidated is the only one that has been carried through to any success.

During all the intervening years leasers were active, and from time to time good orebodies were taken out on a number of properties such as the Mendha and Hamburg, in the Highland district. Several attempts were made to reopen the early mines by company operations, but their production of late years has been mainly by leasers.

Of recent years the work of chief importance has been the development of the big bedded deposits of the Prince Consolidated, Virginia Louise, and Combined Metals properties. The Prince Consolidated and Virginia Louise have been largely productive of low-grade oxidized silver-lead-manganese-iron fluxing ores, and the Combined Metals has developed a large tonnage of silver-lead-zinc sulphide ores.

The Bristol district, a few miles north of Pioche, which is here considered as a part of the broader Pioche district, has had corresponding periods of activity and



ANOTHER VIEW OF THE OLD MINES AT PIOCHE, NORTH 30 DEG. WEST BOUNDARY FAULT PASSES THROUGH THE LOW SADDLE IN THE REAR OF THE BIG DUMP

idleness, with a large production at various times by company operations and leasers. Among the many properties which have been largely productive are the Jackrabbit, Hillside, Mayday, and Gypsy. The activities of the Bristol Silver Mines Co., now shipping about 400 tons of silver-lead-copper ore weekly from the Mayday and Gypsy fissures, are the most important in the entire district at present and have a material bearing on the future of many of the properties.

In the main the area exhibits a wide extent of Paleozoic sediments intruded by Post-Carboniferous acid and semi-basic dikes, cut by several series of mineralized fissures, and later broken into numberless fault blocks by three or more series of post-mineral faults. From the presence of gold and silver veins in a series of andesitic flows in the Fay and Deerlodge districts to the east, it is believed that part if not all of the district was covered by flow rocks at the time of intrusion and mineralization. Over the greater part of the area these flows and a great thickness of sedimentary rocks have been removed by erosion; and after the country had been blocked out by faulting and erosion to a condition somewhat resembling its present topography, recent flows and tuffs covered the country. These too have been almost wholly removed from the greater part of the district, but remnants of them can be found in the Silverhorn and Fairview areas.

Sedimentaries Should Be Further Studied

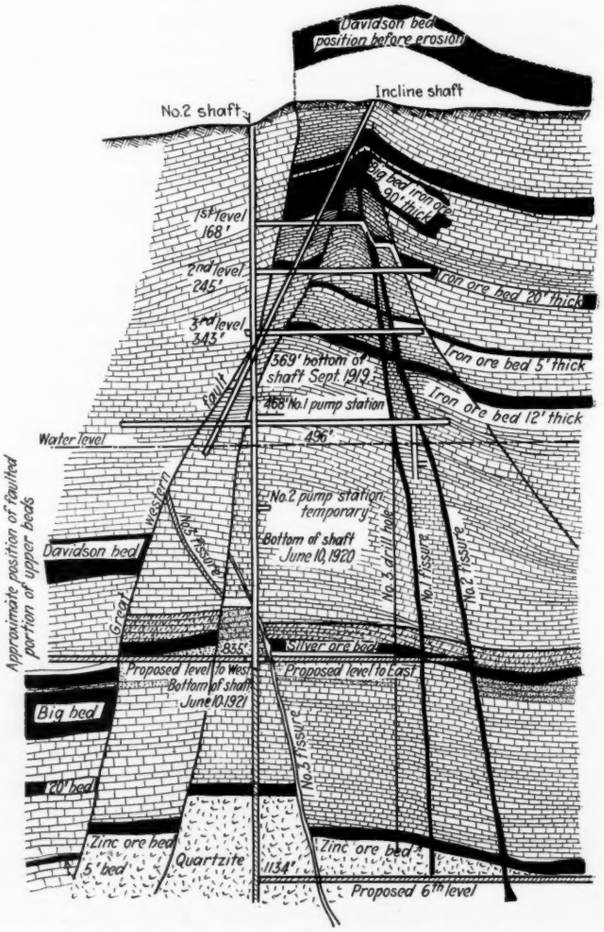
The sedimentary rocks of the region have been studied by Walcott, Spurr, and others, and their age and correlation with other sections determined, but much advantage would result from detailed study of the formations and the isolation of distinctive beds in the limestones above the Mid-Cambrian shales, and it is to be hoped that study of the district by the U. S. Geological Survey can be hastened. There are ore deposits in many of the fault blocks in which nothing but limestone is exposed, where it might be of great economic importance to know in what horizon of the beds the work is located and the probable depth to other beds which have elsewhere been particularly susceptible to mineralization. Few of the limestone beds above the shale horizon are sufficiently distinctive to be easily separated, and this can be done only by the detailed study which the U. S. Geological Survey alone can give them.

The oldest formation exposed in the region is the basal Cambrian quartzite. Deep development of the old mines at Pioche has shown this to be more than 1,500 ft. thick, and it is probable that it is of much greater thickness. In the Patterson Mountains to the north, 10,000 ft. or more of quartzite of similar age is found, and, though it is possible that it may thin out in the direction of Pioche, everything points to a great thickness of quartzite below the bottom of the deepest workings. This quartzite and its thickness is of economic importance from the fact that the most productive fissures of the district, those of the Raymond and Ely, Meadow Valley and Alps mines, have been found wholly within the quartzite. These veins are remarkable for their persistence in length and depth, and though there was a diminishing in silver values and an increase in lead and zinc in depth, it is believed that they will some day be mined for these metals at much greater depth than the present bottom of 1,500 ft.

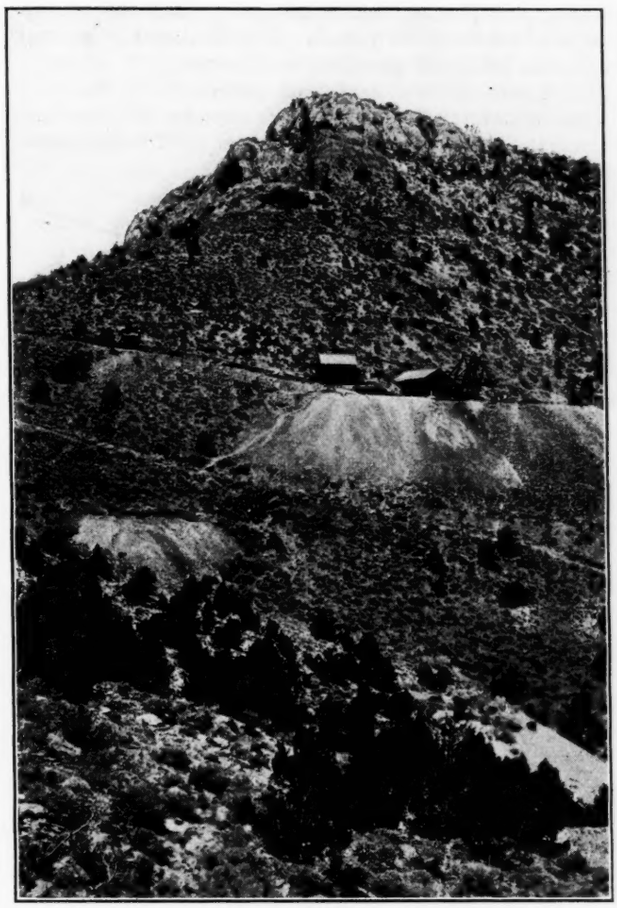
The quartzite has fissured cleanly from top to bottom, whereas the same fissures continuing upward into the limestones and shales have been blanketed, split and soon died out. My observations point to a reasonable conclusion—that, conversely, many of the tight small fissures found in the overlying formations may open out into similar strong fissures when development reaches down to the quartzite. It is believed that future development will make productive mines in the quartzite from fissures of small importance in the formations where they are now opened.

Two Main Shale Beds Developed

Lying conformably above the quartzite is a series of alternating shales and limestones in which the shale beds predominate for several hundred feet. These shales are exposed in numerous fault blocks in the Pioche Mountains and in the Highland Range, and have been extensively developed in the Prince Consolidated and Virginia Louise mines in the flat to the south of Pioche. Here the two main shale beds have been given the local names of the Gladstone shale and the Louise shale. They have sufficiently distinctive characteristics to be identified elsewhere. The Louise shale is highly fossiliferous and has been determined by Mr. Walcott as Mid-Cambrian. The Gladstone bed is that which overlies the quartzite. It reaches a greatest thickness of about 400 ft. It is everywhere highly micaceous and can be distinguished by the shining plates of white mica. The Louise shale lies above the Prince ore bed and under the Davidson ore bed, and has a greatest thickness of about 110 ft. It is a clean brownish shale,



SECTION THROUGH NO. 2 (MAIN) SHAFT WITH INCLINE SHAFT PROJECTED, PRINCE MINE, PRINCE CONSOLIDATED MINING & SMELTING COMPANY



THE OLD SUSAN DUSTER. A PARTLY DEVELOPED ORE-BODY OF THE COMBINED METALS TYPE.

with abundant fossils and without trace of mica or grit. Above the Louise shale are other thin beds of shale in the limestones to a total height of perhaps 1,500 ft. above the quartzite.

About 3,000 ft. of massive and heavy-bedded limestones of Upper-Cambrian age have been found in the Highland Range and are in part represented in various fault blocks in the Highland, Stampede Gap, and Bristol areas. In many of the fault blocks there is as yet no means of determining what horizon of these Upper-Cambrian limestones is represented. For the most part they are light to dark gray, hard and usually quite siliceous, with relatively few pure limestone beds.

Northward from the Bristol mine the limestones are overlain by quartzite beds which have been determined as of Silurian age, and still to the north Devonian and Carboniferous fossils are found in the limestones. In the Silverhorn district are found one or more heavy beds of shale. The total thickness of these formations above the Upper-Cambrian limestones con be determined only relatively, as the intervening country is much broken up and no continuous exposures are found, but it certainly represents several thousand feet at least, or a total of perhaps 8,000 ft. or more of sediments above the Cambrian quartzite.

Four types of intrusive rocks have been found in the Pioche and Highland districts, and related types occur in the surrounding region. Two of these were accompanied by paralleling series of fissures and a related mineralization, and a third may be related to a still later period or stage of mineralization. As previously stated, two series of flow rocks are found in outlying parts of the district, but as there is little or no connection between them and the majority of the ore deposits, they will not be further discussed. The consensus of opinion has formerly favored one of these intrusives, the Yuba dike, as the direct source of all of the ores of the Pioche district, but the present study has shown conclusively that it has been by no means the sole agency of mineralization and possibly is of minor importance as compared with the occurrences of later diorite intrusions.

West of Stampede Gap, and about ten miles west of Pioche, is a massive intrusion of granite in the limestones, and extending to the eastward from this is a dike of granite porphyry or rhyolite porphyry, which can be followed to the eastern end of the mineralized zone. It is locally called the Yuba dike, because the first big contact ore deposit found along it was on the Yuba claim just east of Pioche. The Yuba dike has been separated into segments by a series of heavy faults, striking north-south or north 30 deg. west.

YUBA DIKE EARLIEST IGNEOUS INTRUSION

In its eastward course it shows increasingly the effects of quicker cooling, and might properly be called a rhyolite porphyry where seen in the quartzite at Pioche, but there can be no question as to its identity at any place. It has a strike of from east-west to north 75 deg. west and a dip of from 70 to 80 deg. to the south, and varies in width from 40 to 75 ft. It is believed to be the earliest expression of igneous intrusion in the district.

The diorite porphyry dikes of the district have been seldom recognized, and little or no importance has been attached to them, owing to the common belief in the super-importance of the Yuba dike. I first recognized them in the Comet district on the west side of the Highland Range, about ten miles southwest of Pioche. Three dark-green dikes of diorite porphyry were there found with a strike of north 70 deg. east and a steep dip to the south. Paralleling them was a series of north 70 deg. east mineralized fissures in the limestones and shales. The relations between the dikes and the fissures were such as to suggest a direct connection between the intrusives and the mineralization. Later, similar dikes with the same strike were found at the Point mine, the Ely Valley, and the Pioche Mines Co., in the main Pioche district. Likewise, a most persistent set of mineralized fissures, having a strike of from north 50 deg. to north 70 deg. east and usually between north 65 deg. and north 70 deg. east, has been found at intervals from end to end of the district. This association of the north 70 deg. east dikes and fissures with mineralization is so striking that one is forced to the conclusion that an important period of mineralization followed the intrusion of the diorite porphyry. Several examples of this series of fissures will be discussed in detail later. The diorite porphyry dikes, like the Yuba dike, seem not to have everywhere reached to the present surface.

A rhyolite dike, about 6 ft. wide, somewhat similar to the Yuba dike, but slightly less acid and without the distinctive quartz phenocrysts of that rock, was seen on one of the claims of the Pioche King Mining Co., northwest from the Prince Consolidated.

Exposed in the Hamburg tunnel is a dike of rhyolite porphyry about 6 ft. wide, filling a north-south fault. This dike is post-mineral and of no importance in con-

nection with the ore deposits, except as it may fault them. Its north-south strike is of interest as an indication that the north-south period of faulting is related to the last outpouring of flow rocks.

Three series of mineralized fissures were observed in the district, the east-west to north 75 deg. west fissures; the north 60 to 70 deg. east fissures; and the north 20 to 30 deg. west fissures.

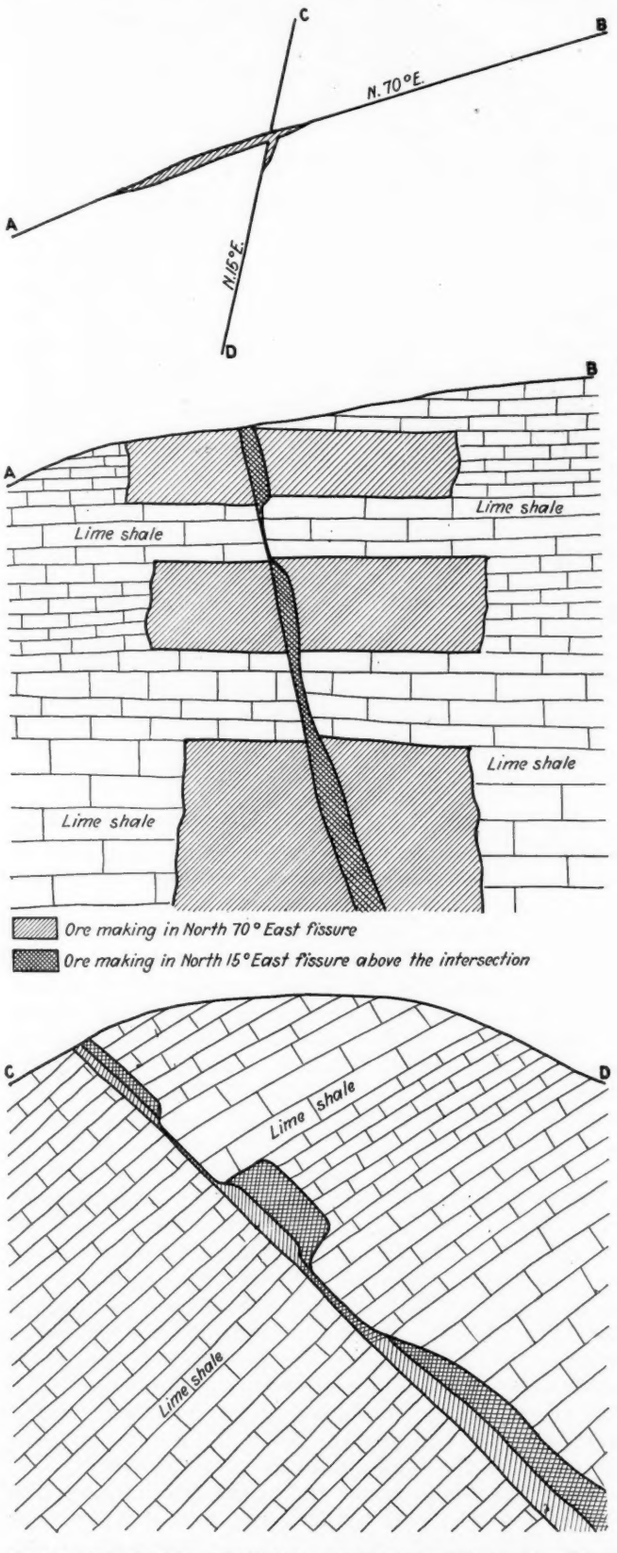
The first set seems to accompany the Yuba dike, with a parallel strike of from east-west to north 75 deg. west and steep dip toward the dike. Those north of the dike, as on the Montgomery-Doll group, dip to the south, and those on the south, like the Mendha, Hamburg, Highland Central and Highland Queen, dip to the north. This is probably the earliest set of fissures in the district, and the ore deposits of this series may be genetically related to the Yuba dike.

The second set of fissures have a strike of from north 60 deg. to north 70 deg. east, with an occasional fissure which turns as much as north 50 deg. east. The greater number dip to the south, though here and there one is found with a steep dip to the north. They parallel the strike of the diorite porphyry dikes, and in parts of the district the relation of the mineralization in the fissures to the dikes is clearly apparent, and it is probable that there is everywhere some connection between them. Fissures of this type are the Mayday and Tempest fissures, in the Bristol district; the Florence, west of Stampede Gap; the mineralized fissures which crosses the big garnet-iron outcrop on the Manhattan, in Stampede Gap; undeveloped fissures on the Edwards and Great Western groups, in Stampede Gap; the Wheeler fissure, in the Highland district, which is about north 50 deg. east; the Alps fissure, in the quartzite east of Pioche; and, last but not least, the Raymond and Ely-Meadow Valley fissure, from which the chief production of the Pioche district was taken.

The third set of fissures, those with the north 20 deg. to north 30 deg. west strike, is the most difficult of all to interpret or weigh the importance of the accompanying mineralization, because of the fact that there is a big series of parallel faults of this strike which are definitely post-mineral. The one place where there can be no question as to the accompanying mineralization is in the high-grade fissures in the Prince Consolidated, which have a strike of from north 20 deg. to 30 deg. west and dip to the northeast. Like the first two series of fissures, they show small displacement of the beds. The No. 1 fissure has yielded quite a tonnage of good lead-silver ores. They have been thought to be the channels through which the big beds of the Prince Consolidated and Virginia Louise were replaced and mineralized, but though they in places cut some of these beds they do not conform with the beds, and in my opinion they do not represent the main channels of circulation, if they have any connection whatever with the mineralization of those beds. Most of the faults of this strike (north 20 to 30 deg. west) which were seen in the district were post-mineral faults cutting both of the earlier sets of mineralized fissures.

If the mines of the district are ever opened to depths of 3,000 ft. or more, as I believe they will be, it will be found that there are three sets of intersecting mineralized fissures, each faulting those earlier than itself, as do the fissure systems at Butte. However, there can be no question, though the opposite opinion has been widely held in the district, that the north 30 deg. to north 50 deg. west faults which bound the quartzite in the main Pioche district are later than the ore deposits which have been so far developed and in no way mark the limits of possibilities for ore.

There are several series of post-mineral faults, a correct understanding of which is essential for the finding of faulted portions of ore deposits. Two of these,



PLAN AND CROSS SECTIONS ILLUSTRATING INFLUENCE OF FISSURE INTERSECTIONS AND DIFFERENT LIME STRATA ON THE LOCALIZATION OF ORE DEPOSITS IN THE BRISTOL DISTRICT

the north 30 deg. west faults and the north-south faults, are of big displacement. They have had much to do with the blocking out of the district in its present form, and with the throwing of faulted sections of ore deposits from one property to another. The others, as the south 70 deg. east faults, the north 32 deg. to north 45 deg. east faults and the north 15 deg. east faults, are of lesser displacement and usually affect only the search for faulted orebodies within a single property.

The north-south faults were observed particularly with respect to their faulting of the Yuba dike, where the extent of their throw is often measured in hundreds of feet. As before stated, they have, in every observation made, lifted the block east of the fault with a drag to the south, so that in searching for the dike or for veins cut by the north-south faults, one must look to the south when going east and to the north when going west. These faults cut the Yuba dike and the diorite dikes, and so are later than those periods of intrusion. No evidence whatever of any mineralization was seen along this series of faults.

The north 30 deg. to north 50 deg. west faults are economically of great importance, as they have faulted many of the important orebodies of the district. They have generally been considered as pre-mineral, rather than post-mineral, but in so far at least as concerns the main fissure veins of the district, such as the Raymond and Ely-Meadow Valley and Alps fissures, and the Yuba dike and its contact deposits, they are post-mineral. Likewise, as concerns the big bedded deposits of the Prince Consolidated and Virginia Louise, and the smaller precious-metal beds of the Half Moon type, they are post-mineral. They are usually faults of large displacement, reaching into hundreds of feet, though the bigger faults of the system may have lesser sympathetic faults, such as are seen with the Davidson fault in the Prince Consolidated.

In different parts of the district other post-mineral faults are found. Of these are such faults as the Endline fault between the Prince Consolidated and Virginia Louise, the north 32 deg. east faults in the Combined Metals, and the north 37 deg. to north 45 deg. east faults in the Half Moon. It is probably that with these lesser faults, as with the bigger faults, there is a constant direction of displacement, which, once worked out for a given series of faults, can be successfully applied in development. These faults vary from a displacement of a few feet to perhaps a maximum of 150 ft.

The classes of ore deposits found in the Pioche district are as varied as the history of the camp, and its ups and downs are but a record of the working out of one type of deposit and the period of quietude until someone developed the possibilities of another class.

The failure of past development has been its inability to learn the interdependence of the several types of ore deposits and the possibilities for following from one to the other in one property. The recent attempt at deeper development on the Prince Consolidated is the most hopeful indication of a real future for the Pioche district, and it will fail unless it is carried to a conclusive test, as it should be.

The ore deposits of the district may be divided into the following main classes: Fissure veins in quartzite; contact veins along intrusive dikes; bedded deposits, and fissure veins and fissure intersections in upper limestones.

The original discoveries of the camp were the Raymond and Ely-Meadow Valley veins of this type. They

LOOKING BACK AT THE OLD CAMP OF PIOCHE

are remarkably persistent fissure veins in quartzite which have been mined for more than 2,000 ft. along the strike, up to 1,200 ft. in depth, and have widths of from 2 ft. to 9 ft. They yielded large amounts of high-grade silver and silver-lead ores, producing over $16,000,000 from these two mines alone in the years from 1869 to 1875. Most of these workings were inaccessible at the time of my visit, but evidences are everywhere seen of the extent of the old workings.

The ores as a rule became lower grade and baser in depth, and probably the high values above were in part at least due to secondary enrichment. It is to be expected that these ores will give place to baser ores in depth, as did the contact ores on the Yuba dike, but it is believed that the veins will persist and ultimately be mined to much greater depths than the present deepest workings.

What is believed to be the extension of some of these veins has been found in the overlying shales southwest of the boundary fault between the quartzite and the shale. Here they have pinched up to almost nothing, like the characteristic fissure veins seen elsewhere in the district in these horizons. A parallel case is seen in the Comet district on the west side of the Highland Range. The Comet vein, which is in the basal Cambrian quartzite, is a strong fissure 3 ft. to 9 ft. wide, but near-by fissures in the limestones and shales are almost impossible to follow except where they swell in crossing certain limestone or lime-shale beds.

Other Fissures Offer Possibilities With Depth

There should be a good possibility for other fissures in the district, which may be of small importance in the upper horizons, to open out into strong fissures when followed down into the quartzite. Fissures of this type are the north 20 deg. to north 30 deg. west silver-lead fissures of the Prince Consolidated and fissures of the east-west and north 70 deg. east series in the Highland district. The strength of the fissures in the quartzite and their weakness in the overlying formations are due to the physical reaction of the different formations to the fissuring. The quartzite broke cleanly from top to bottom because of the uniform nature of the rock, whereas the more yielding and constantly varying nature of the alternating limestone and shale

beds above, blanketed and dissipated the force of the fissuring.

Just as the first work of the district was the exploitation of those quartzite fissures which were exposed by erosion, the final stages of development will lead down to the quartzite fissures which underlie the many lesser fissures found in the higher formations.

Contact Veins Along Intrusive Dikes

The next period of extensive operations in the district followed the development of the contact orebodies along the Yuba dike in the main Pioche district. The earliest discovery was in a crosscut from the 1,200 level of the Raymond and Ely. A winze was sunk 300 ft. on the so-called black ledge, a contact vein of zinc blende between the dike and the quartzite. There being no market in those days for zinc, this orebody was never worked, but it is reported that later big bodies of silver-lead ore were stoped nearly to surface on the Yuba and Mazeppa claims.

The Yuba dike can be traced for about ten miles to the west, and in many places mineralization shows along the contact. It is in successively higher beds of the Cambrian limestones as it progresses westward, and it is possible that, as with the fissures, the contact mineralization will pinch to nothing in certain limestones and bed out to form good bodies of ore in the more soluble members. Prospecting has been active recently on the western part of the dike in Stampede Gap, and it is to be hoped that it will be followed up by deeper development, as there should be big possibilities for deep ores along this contact.

Practically no work has ever been done on the diorite porphyry contacts, though some mineralization is reported from different localities. However, from the close apparent relationship between these dikes and some of the north 70 deg. east fissures, it is possible that contact ore deposits may be developed along them.

Bedded Deposits Divided Into Three Classes

Several types of bedded deposits are to be noted in the district, which differ perhaps more in accordance with the horizons at which they have formed than in manner of origin. It is indeed possible that all three types may be found bedding out from one fissure as development proceeds, for the most strongly marked characteristic of the mineralization of the region is the habit it has of bedding out from an otherwise often barren fissure, where the fissure cuts certain favorable contacts or soluble limestone beds. The bedded deposits may be divided into three classes: The thin, gold-silver-lead beds at limestone-shale contacts; the silver-lead beds in limestone; and the big manganese-iron-silver-lead beds.

Beds of the thin gold-silver-lead type are found on the Abe Lincoln, Half Moon, Pioche Mines Co. and other properties in the Pioche Mountains two or three miles northwest of Pioche. They are siliceous replacements along a limestone-shale contact, that at the Half Moon being typical of the class. Here the bed is from 6 in. to 15 in. thick, with an average of less than 12 in. It lies between limestone above and shale below, and in different minor fault blocks dips at flat angles to the east and north. Values are reported to have been around $20 to $25 to the ton, about equally divided between gold and silver, with a little lead. A small mill operated unsuccessfully for a while, its chief result being to demonstrate the economic impossibility of successfully mining thin, flat beds of this character. This type of ore bed offers little attraction except to the chlorider who occasionally takes out a few carloads.

A type of bedded deposit from which large returns have been won is that of the bedded deposits in limestone which are directly related to fissure veins. Chief among these are the Mendha, Hamburg, Highland Mary, and Highland Queen mines, in the Highland district, about seven miles west of Pioche. Production from the Mendha and Hamburg properties is reported as in excess of a million dollars. Profits certainly were not in a fair ratio to the output, because of the chloriding methods of operation, but the possibilities of this type of deposit under proper methods of development and operation are excellent. The fissures from which these beds were formed are of the east-west series. In certain horizons in the limestones they may open out to workable size and value, but in others they may be difficult to even trace. Oftentimes they may be not so much beds as swells in the veins, a condition due to the more soluble limestone they are following.

Conditions Warrant Further Development

Development has usually been confined to the one commercial bed first opened by the prospector, and no serious attempt at real development has ever been made. In some instances such an attempt, if carried through to a finish, should have good chances for developing valuable ore deposits at other horizons. The beds of this type are usually found in the Upper-Cambrian limestones at an undetermined but considerable distance above the quartzite. Chief values are in silver and lead, with some gold, and the ore is usually of direct shipping grade, though some more siliceous beds running about $20 in gold, silver, and lead have been partly developed.

Prospecting has discovered many other smaller beds of silver-lead ores of this type along fissures of the east-west and north 70 deg. east series, and some of them have yielded small shipments of high-grade ore. Their chief importance is as possible leaders to bigger beds at depth.

One other bed of a related type is of interest because of the wide publicity recently given to the camp of Silverhorn, about twenty-three miles north of Pioche. The deposits here are in a much higher horizon than those to the south. They lie between a limestone-shale contact, apparently in genetic connection with an acid dike. A siliceous bed of considerable thickness near the dike was formed by replacement at this contact, which dips northerly at from 20 to 30 deg. Erosion has stripped the overlying shale from the hanging wall of the quartz and cut away the softer dike at the foot, so as to leave an outcrop of quartz with a deceptive appearance of great size. The quartz thins out rapidly in the direction of the dip, and any attempt to follow the quartz to depth will be a failure. It represents a bedding out at a high horizon of the final siliceous solutions with a little mineralization, and so may indicate a channel of circulation which at some depth may have bedded out again to form valuable deposits of ore, but whether or not such other bedding may occur within economic limits of sinking is problematic. Added to the apparent size of the outcrop was the bait of superficial rich chlorides and a little argentite, but it is doubtful if the body of the quartz or any considerable part of it will carry payable values.

At the Prince Consolidated and Virginia Louise

mines, about two miles south of Pioche, several big replacement ore beds have been developed and partly mined. The average of the ores is about 3 oz. silver, 3 per cent lead, and 3 to 6 per cent zinc, with an excess of manganese and iron over silica of from 15 to 30 per cent. As the beds are oxidized they are a valuable fluxing ore, and the Prince has shipped about 800,000 tons to the Salt Lake smelters, earning good dividends from the shipments. The Virginia Louse has shipped a lesser but considerable tonnage, and a recent report by Walter Harvey Weed estimates that there is from 500,000 to more than 1,300,000 tons of positive and probable ore in the mine. There are good prospects for finding more ore in both mines. The ore was formed by a complete replacement of limestone beds, intercalated with the shales which overlie the Cambrian quartzite.

From my own observations it appears that as yet no satisfactory explanation of the source of the mineralization has been found, nor will the full possibilities of the deposit be known till this is determined. The deposit is cut off on the west by a north 30 deg. west fault which is roughly parallel with the apparent long axis of the deposit, and part of one big bed at least is cut off on the east by a north-south fault. These faults are certainly post-mineral, and there is reason to expect to find big sections of the ore beds beyond them, but the direction and extent of lateral movement along them must first be determined before they can be found other than by accident. The only indication seen of a possible source of mineralization of these beds was in the fact that they seem to die out to the north in the Prince and to thicken toward the south in the Virginia Louise. This may serve to indicate the approach to the main channel of circulation from which the replacement spread.

Some have believed that the ore beds are not the result of the oxidation in place of beds of primary sulphides, but are a redeposition of migratory oxides. I can see no reason to believe that they were formed in other than the same manner as the big sulphide bed of the Combined Metals, Inc.

The Combined Metals, Inc., on the west end of the Panaca claim, but in the shale beyond the fault which cut off the rich Raymond and Ely vein in the quartzite, has a replacement deposit in a bed of limestone in the Gladstone shale, which is of much importance. Here has been developed a body of 150,000 tons of lead-zinc-iron sulphides carrying 8 oz. silver, 8 per cent lead and 18 per cent zinc, in a bed that is 40 ft. thick at center, 5 ft. thick at the edges, with an average thickness of 27 ft.; 40 ft. to 167 ft. wide, with an average width of 92 ft.; and over 400 ft. long, with a possibility of finding faulted extensions to the west.

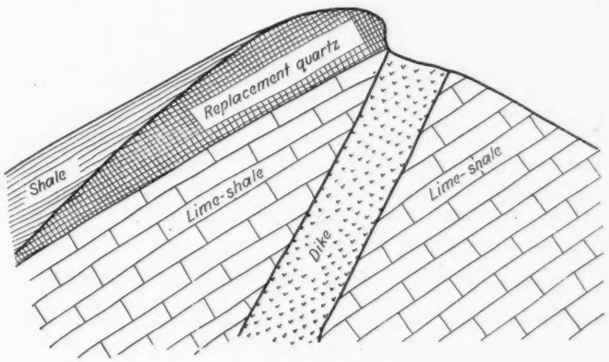
The cross-section on p. 280 of the Prince Consolidated, furnished by the company, gives a general idea of the lay of the beds and the north 30 deg. west fissures and faults. Though the correctness of assumptions based on drilling results remains to be proved, this sketch gives an excellent idea of the upper beds.

The possibilities of the type of ore deposit under discussion have best been demonstrated by the Hillside, Mayday, Gypsy, and other mines in the Bristol district. This group of mines has been worked at various times by a number of companies and individuals, and some of them are said to have made large and profitable productions, the total being reported as several million dollars. As often as worked they have been reported as bottomed, due to the pinching of the veins in certain limestone beds; but deeper work has found and yet will find other splendid orebodies.

Among the main fissures are the Mayday, Hillside, and Tempest of the north 70 deg. east series of fissures, and the Gypsy of the north 15 deg. east series. The Mayday and Tempest are parallel and several hundred feet apart on surface; the Hillside may be an extension of one of these, but the connection is obscured by faulting. The Gypsy has been mined to a depth of about 1,700 ft. on the dip of the Mayday fissure, or 900 ft. vertically. The surface outcrop is not big and is marked by irregular streaks of iron and copper oxides.

The ore to the 800 level has been a mixture of iron, copper and lead oxides, with good silver values. Between the 800 level and the bottom some galena and blende is found.

The Hillside mine exhibits characteristics similar to those above noted, and a big body of rich sand carbonates and silver-lead-copper oxides has been mined out to the 900 level. This is at a higher horizon in the Upper-Cambrian limestones than the Mayday, and it should have the same possibilities for opening out at other lower horizons. Similarly, other smaller orebodies that have been mined at intersections of other north-south fissures with the Mayday and Tempest fissures should have possibilities at lower horizons.



REPLACEMENT DEPOSIT IN LIME—SHALE CONTACT AT SILVERSHORN

I believe that there is a big future for the district. There are a great number of mineralized fissures of each class, many unprospected dike contacts, and several important sections of faulted ore deposits that it should be possible to find. If the district is thoroughly studied as a whole, a sound basis of correlation of the deposits worked out, and the lessons of this study applied intelligently to the individual property in a comprehensive plan of development, other important orebodies will be found. As in the past, the work will lag, and the district be dull at times till some courageous pioneer proves that in depth one may pass from one type of deposit to another within the same property. Then will come a rush of development that will make mines from many of the great number of mineralized outcrops in the district.

The possibilities for extension in depth are great, and though the investigator is not yet in a position to predict such a future, there is sufficient copper in evidence in parts of the district to show the presence of that metal in the mineralizing solutions, and it may be that here, as in some other districts, below the zinc copper will be found.

Roasting Zinc Ores for Electrolytic Reduction

Formation of Zinc Ferrate Not Always Entirely Accountable for Poor Extraction—Extremely Fine Grinding Deleterious—Quick Roasting With Thin Beds Generally Advisable—Draft Regulation Important

BY THOMAS FRENCH
Written for *Engineering and Mining Journal*

IN A PAPER which I wrote in 1917,[1] reference was made to the difficulty of obtaining a high extraction of zinc after roasting ores for the reduction of zinc by the electrolytic process. At that time the extraction of zinc at one large plant varied from 40 to 60 per cent, whereas at another, 70 per cent was above the average. In the paper mentioned, it was stated that extractions of 90 per cent of zinc had been obtained from low-grade ferruginous ores, though 95 to 97 per cent could be obtained from concentrates containing 45 per cent of zinc.

During the Great War the chief concern of the producers of zinc was to obtain a large output of zinc, regardless of the percentage of extraction, although even at that time the low figures occasioned a certain amount of alarm. It was estimated that if the price of zinc fell to 7c. per lb., or even to 9c., under some mining and operating conditions, the profit would be insufficient to warrant operation of the plants. Since then, a great amount of valuable experimental and working data has been accumulated, and much improvement in roasting has been accomplished, but still the results are lower than was predicted.

MODIFICATION OF ROASTING METHODS ESSENTIAL

The object of this article is to suggest various means by which the methods of roasting may be so modified as to give increased extractions. Some of the suggested alterations are quite at variance with the present recognized practice, but as a pioneer in the electrolytic reduction of zinc ores, I actually obtained the results described.

If, through overheating, ferrate of zinc has once formed, no ordinary modification of the roasting process can be made to cure it. Some ores, in which the zinc probably exists in combination with iron as ferrate of zinc, cannot be made to give a high extraction of zinc, no matter how carefully the roasting operation may be conducted, and some ores may easily be seen to have undergone thermal metamorphism.

In the past, ferrate of zinc has often been blamed for poor extractions of zinc when in fact it was only partly responsible. It requires a considerable degree of overheating, and time, completely to combine all the iron with the zinc at the temperature used in roasting, and even then there is a definite limit to the amount of zinc that may be combined with the iron. Where a markedly low extraction of zinc occurs, the reason may more often be found in incipient fusion or sintering of the ore through the use of too high a temperature in the earlier stages of roasting, or in the failure to convert the sulphide wholly into oxide or sulphate. Once sintering has occurred—and this is likely to happen in furnaces with rotating stirrers—it is difficult to drive off the sulphur without using an excessive temperature.

[1] "The Future of Electrolytic Zinc." *Trans.* American Electrochemical Society, Vol. 32, 1917.

Many investigators have insisted on the necessity of grinding the ores extremely fine, and data have been given prominence that might be considered conclusive proof of its benefits. It has been recommended that a large proportion should go through 200 mesh. There are, however, certain objections to fine grinding. Not only is much dust produced in the roasting furnace and carried into the flues, but when falling from floor to floor the fine state of division of the particles of sulphides causes them to flash, producing sintering and a temperature that is often far in excess of that necessary to form ferrate of zinc. For these reasons I have always endeavored to grind the ore so that as little as possible is either finer or coarser than 30 mesh. High extractions of zinc have been obtained from ferruginous ores that have been roughly crushed to pass an 8-mesh screen. This is, however, the other extreme, for although the ore is completely roasted, it is found that the zinc does not dissolve sufficiently rapidly, and that by further grinding after roasting an extraction of an additional 1 per cent or possibly 2 per cent can be obtained.

Some finely ground ores and concentrates have when wet a tendency to cake and form small lumps. Some of these in roasting pass through the furnace from hearth to hearth as small balls, which never break, and as they are only superficially roasted the center contains unaltered sulphide. In some instances a considerable loss in extraction occurs in this way. A mechanical contrivance should be placed on the drying hearth of the furnace to break up these lumps; otherwise they should be separated by sifting from the roasted ore.

SHORT ROAST ADVANTAGEOUS

In reviewing the data that have been published it is very noticeable that the ore is kept in the roasting furnace for a much longer time than is necessary or good for it. If temperature and time are involved in the formation of ferrate of zinc, the shorter the time the ore is exposed to possible periods of excessive temperature the less likelihood is there of the formation of ferrate of zinc. Following the practice which obtains in roasting ores for the retort process, it appears to be customary to keep the ore in the furnace for a long period, in some cases as much as twenty-four hours. This implies that for the same output the bed of ore on the hearths must be extremely thick.

In mechanical roasting furnaces the output is determined by the speed of the rabble arms and the number and disposition of the rabble blades. The amount of feed must be regulated to suit these, and by adjusting them to one another the ore may be kept in the furnace for any desired length of time, provided the depth of ore is within reasonable limits. The depth of ore on the hearth must be so regulated that the maximum of sulphide is converted into oxide or sulphate before it leaves the last hearth, with the minimum amount of

auxiliary heat. It is here that the greatest judgment is required in order to obtain the best results. The difficulty is all the greater because any variation in the ores demands a different adjustment. The matter is further complicated by the fact that the rabble blades cannot be readily altered. Fortunately, only a little trouble is involved in varying the speed of the rabble arms.

Optical Pyrometer Necessary to Efficient Regulation

Oxidation is active on the freshly exposed surface of the ore on the middle hearths. Within a few seconds, however, the intense heat generated by the rapid oxidation on the surface dies down, and oxidation on and under the surface then proceeds much more slowly. Although pyrometer couples sunk in the roasting ore, as is often the practice, are useful in giving a general average of the temperature of the hearth, they do not give the actual temperature at which the ore is being roasted on the surface, and it is on the surface that the greater part of the roasting is done. A slight increase in the auxiliary heat for a short time may result in a sufficiently excessive superficial temperature to form ferrate of zinc or to cause sintering to take place, which the sunk couple would not register, as it would give only an average of the temperatures of the exterior and interior of the mass. An optical pyrometer is necessary to give the correct temperature at which oxidation is taking place on the surface.

To obtain the best results in roasting, the ore should be turned over as soon as the surface heat has died down. For this purpose the speed or number of the rabble arms should be considerably increased, and the number and pitch of the rabble blades must be correspondingly altered to prevent the ore from traveling over the hearths too rapidly.

Details of Preferred Practice

The speed at which roasting takes place varies with different ores, but with most ores a seven-hearth Wedge furnace with an internal diameter of 22 ft., for instance, may be made to deliver the completely roasted ore with a considerable proportion of sulphate, sufficient to prevent either a loss or accumulation of acid in the dissolving department, at the rate of about one ton per hour. The ore should not remain in the furnace for more than four and one-half hours, and three and one-half hours is often sufficient. At this rate, the depth of ore on the hearths must be less than that usually employed when the ore remains in the furnace from six to twenty-four hours. The thinner the bed of ore and the more it is stirred, the sooner will it be roasted. In a laboratory muffle furnace, for instance, a thin layer of ore may be completely roasted in an hour or less. It is evident that with a thick layer of ore, and the slow stirring necessary to retain the ore in the furnace for an extended period, many of the particles of the ore may chance never to be near enough to the surface to be completely roasted, and a lowered extraction will result.

The draft of the furnace should be limited to the utmost. A definite amount of oxygen is of course necessary, but the excess employed should be as little as possible. This statement, again, is at variance with that of other investigators, but I have obtained the best results by that means. In furnaces of the McDougall or Wedge types, the damper at the outlet of the furnace should be closed sufficiently to cause the doors on the top floor to smoke to the slightest degree. Retarding of the draft has more than one effect. Among other things it prevents an excessive amount of dust from being carried into the flues when finely ground ore is roasted. As the ore falls in a cloud of dust from floor to floor, it is probable that the concentration of oxygen in the vicinity of the stream of particles is so reduced that it prevents the extremely high temperatures caused by the flashing of the ore and the formation of ferrate of zinc. It has also the effect of preventing the too rapid oxidation of the ore on the upper floors, which may produce a temperature high enough to sinter the ore.

Coal-fired Furnace Inefficient

When coal-fired furnaces connected with roasting furnaces are used as sources of auxiliary heat, a considerable amount of draft is required to cause the fire to burn rapidly enough to provide sufficient heat for the complete oxidation of the ore. This type is not to be recommended, as the heating is not only too local in its action, but it is also an inefficient and costly method. Producer gas can be much more conveniently applied at the points where it is most required, but it also is too cumbrous and costly when compared with oil firing. The oil necessary to roast a ton of ore with limited draft does not usually exceed five gallons and is at times only half of that amount. When this is compared with the amount of coal used in some of the larger works, where it varies from 300 to 600 lb., and the concurrent labor is considered, the advantages of oil firing are apparent.

Double Roasting Sometimes Necessary

Occasionally, incompletely or under-roasted ore is produced, generally when a breakdown has occurred in the roasting furnace. It becomes a difficult matter to dispose of this ore economically. I have found that the best method to adopt is to mix the under-roasted ore with a suitable small coal, and run it through the furnace a second time. If the ore has merely cooled off too much to finish the roasting on the lower hearths with the auxiliary heat that is available, it is only necessary to scatter a sufficient amount of small coal onto these hearths. It soon becomes intimately mixed with the ore and provides sufficient heat to complete the roasting. If the partially roasted ore has been spoiled through sintering, it must be reground before it is mixed with the coal.

When ores rich in sulphide are mixed with coal and roasted, little volatilization of zinc is noticeable. There is, of course, no advantage in roasting a rich sulphide ore mixed with coal, as there is sufficient heat in the upper hearths to burn off the sulphur without the aid of auxiliary heat; but when a carbonate or silicate ore mixed with a proportion of sulphide is to be dealt with, the only courses open are separation by concentration, dissolving out the carbonate or silicate and roasting the sulphide residue afterward, or mixing with sufficient ground coal to provide the heat which in a richer sulphide ore is supplied by its oxidation. Were it not that oil is so easily applied in roasting, there can be little doubt that the mixing of coal with the ores when they reach the lower hearths would be largely used in the future, as the extraction of zinc from ores treated in this way is all that can be desired. When, however, low-grade ores are being treated, an excessive amount of oil or other fuel would be necessary, and it is here that a mixture with coal would be invaluable. The coal used

for this purpose should be a free-burning one, of a non-caking character, and one containing as little ash as possible.

My observations have indicated that the percentage of zinc that can be extracted from an ore roasted with ground coal, compared with the same ore roasted with auxiliary heat, is less only by the amount of ash in the coal used; if this is deducted the percentage of extraction is about equal in both methods. It is, however, an extremely difficult matter to determine this with any degree of accuracy, for the weight of two successive batches of roasted ore from a given quantity of ore is seldom the same, on account of unequal oxidation and loss of dust, even when every effort has been made to have all the conditions of roasting exactly similar.

When complex ores containing a moderate percentage of lead are treated with ground coal, there does not appear to be any more danger of the lead separating in the metallic state, when reasonable care is used, than there is from the reaction of sulphide of lead with oxide or sulphate. If the lead is reduced it is in a fine state of division, and it does not show much tendency to run together. When the reduced particles of lead reach the surface they are apparently quickly reoxidized.

Furnaces of the McDougall or Wedge types are usually up-drafted, and hitherto they have not been notably successful when down-drafted, on account of the difficulty of keeping the upper doors free from sulphur fumes. This difficulty may be overcome by connecting the upper hearths with the flue, and bypassing a small part of the gaseous products of combustion by means of dampers, to prevent the escape of fumes into the roaster building. The small quantity of auxiliary heat that is required for the purpose of igniting the ore is supplied to the top hearth by means of oil, producer gas, or an ordinary coal-fired furnace placed on a special platform at that level. If the doors are made to fit well, there is not much difficulty in siphoning the gases downward. This type of furnace has the great advantage of carrying the hot products of combustion of the ore over the partly roasted ore on the lower hearths, where the sulphur content is too low to maintain combustion, instead of upward over the ore on the upper hearths where combustion is already active.

Zinc Volatilization Being Studied

At the Intermountain Station of the U. S. Bureau of Mines, Salt Lake City, Utah, in the investigation of the chemistry of the volatilization process, the determination of the vapor pressure of zinc chloride over the range of temperature 300 to 700 deg. C., which is one of the essential factors of the above equilibria, has been completed. Values obtained by the static type of apparatus recently designed have given results consistent with boiling-point determinations found in the literature. A satisfactory method for preparation of c.p. anhydrous zinc chloride, free from zinc oxide or hydrochloric acid, has also been worked out. The experiments on gas velocity with zinc oxide plus salt plus silica show that the percentage of zinc volatilized is independent of the gas velocity, but that the volatilization of salt increases with it, although the air is partly dried by passing through calcium chloride. In the mixture of lead and zinc oxides, the percentage of zinc volatilized increases with the percentage of lead volatilized, much of the zinc going off as water-soluble zinc chloride.

Dichromates Valuable in Differential Flotation

Results of the co-operation work of the U. S. Bureau of Mines with the State of Colorado will be published soon by the Colorado Bureau of Mines. The work was devoted mainly to the low-grade complex sulphide ores in the state, and the field report covered all properties working such ores. The ore dressing was confined largely to the application of differential flotation, as influenced by chemical agents, to the complex iron-zinc-lead ores containing precious metals. The results showed that potassium dichromate (or sodium dichromate) in slightly acid solution is an efficient agent in separating zinc sulphide from iron and lead sulphides; it has since been applied with success to the complex sulphide ores and sludges of the Vinegar Hill district, in Wisconsin. In addition, some cyaniding work was done on oxidized ores from the Creede district; and the Caron-Clevenger process for the treatment of refractory silver ores containing pyrolusite was successfully applied to ore mined near Del Norte, Col.

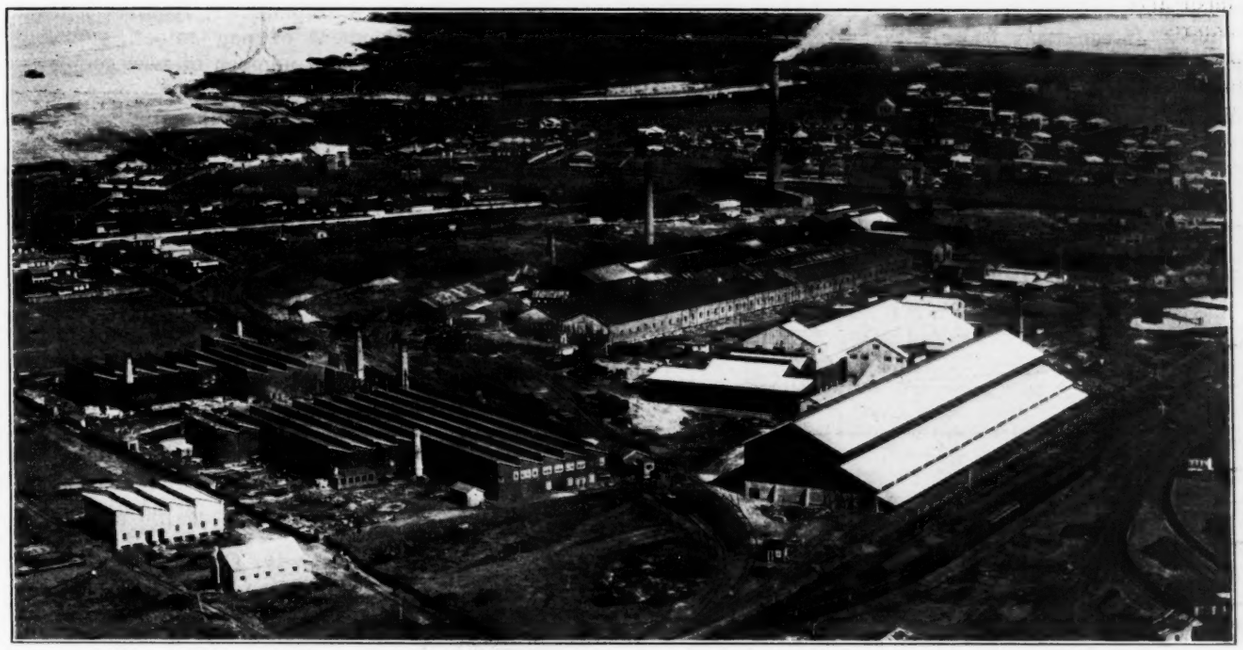
Magnesite Deposits Examined in Pennsylvania

About the middle of the last century most of the Epsom salts used in the United States was made in Baltimore from magnesite mined in Pennsylvania. The use of Epsom salts has continued, but the mining of magnesite on a commercial scale in Pennsylvania ceased prior to 1860. The demand for magnesite on the Atlantic seaboard resulted last summer in an investigation of the possibility of working the Pennsylvania deposits profitably, and that the U. S. Geological Survey might be informed concerning the recent developments, the deposits were examined by R. W. Stone.

The deposits examined are near the oxbow of Octoraro Creek, on the Pennsylvania-Maryland state line. Some work has recently been done on a deposit just east of Goat Hill, in the southwestern part of Chester County, about two miles north of Rising Sun, Md. The magnesite occurs in the state-line serpentine, and all the old pits recently reopened are within a few rods north of the state boundary.

The work done, which consisted of re-excavating the pits, quarries, open cuts, and a shaft that had become filled with dirt, showed that the magnesite occurs in a fine network or stockwork of small veins, most of them less than an inch thick. There are apparently two principal systems of veins, which cross at right angles; the veins of the north-south system stand nearly vertical, but those of the east-west system dip southward at a high angle. Two veins were uncovered, one about 14 in. wide and the other, which was found a few rods farther east, in an open cut, about 12 in. wide. A thorough exploration, including the reopening and drainage of a shaft with underground drifts, failed to disclose any larger veins, but it is reported that a body of magnesite about 30 in. wide was found in the shaft at the crossing of two principal veins.

The development work completed last fall shows that the quantity of magnesite available close to the surface is small and that many tons of waste would have to be handled to produce a single ton of ore, and production on a commercial scale was therefore not attempted. The magnesite is of the white amorphous variety like that produced in California and Greece. It has the typical curved porcelaneous fracture and is apparently of high grade.



PORT KEMBLA, NEW SOUTH WALES, AUSTRALIA

Australian Mining Conditions

Low Metal Prices and High Costs Restrict Activities—Western Australia Leading Gold-Producing State—Gold Premium Alone Makes Possible Operation of Many Mines—Government-Owned Mines Not Highly Successful—Activity in Petroleum Prospecting

By Peter G. Tait
Editor *Chemical-Engineering & Mining Review*
Written for *Engineering and Mining Journal*

THE YEAR 1921 was undoubtedly the worst ever experienced in the history of Australian mining. Low metal prices and high production costs made it impossible for the companies to make ends meet, and under the arbitrary methods of adjusting wages and labor conditions it was, unfortunately, necessary for the economic pinch to be felt before the labor unions would budge an inch. They failed to realize, because they did not want to, that war-time and peace-time conditions are altogether different; that the nation has to get back to normal as other nations are doing; that owners, small and large alike, are not prepared to deplete their wasting assets without some return.

However, the truth now appears to have penetrated the dullest intellects, and a gradual revival may be expected. The chairman of the North Broken Hill, at the last meeting of shareholders, stated that working costs, compared with the first half of 1914, had increased by 155 per cent, whereas the price of lead was slightly above the pre-war figure. After considerable opposition, the Wallaroo & Moonta and the Mount Lyell copper mines were able to convince the courts by production of their cost sheets and independent examination of the accounts, that a readjustment of the wage rate was absolutely necessary. The first-mentioned company actually closed down for several months and the latter threatened to do likewise.

At the end of October, the famous Mount Morgan mine, which has been shut down since May, obtained the sanction of the Queensland Court to reduce wages by 20 per cent, making the new minimum wage 10/10 per day. The government will subsidize operations to the extent of £1,000 per week, by way of rebate on railway freights, and the greater part of this amount will be distributed pro rata, raising the minimum wage to 11/9 per day. Even at these reduced wages the companies do not expect to make a profit, their aim being philanthropic rather than selfish. At the same time, they will probably lose less than if the mines and works were idle, because of the overhead charges which have to be met in any event.

Looking back, one cannot help thinking of the huge sums lost by the employees and by the community through the short-sighted policy of the unions which caused the Broken Hill strike, beginning in May, 1919, and lasting for eighteen months. It was during this period that silver reached such phenomenal prices. It is not alone the unions that have to be blamed for huge losses sustained by the industry. In 1920-1921, the muddling of the government in connection with the control of the metal industry was responsible for a loss of £500,000. Copper which might have been sold for £110 per ton was ultimately thrown on the market when the price was down to about £70. Through the two circumstances noted the mines of Australia lost perhaps £2,000,000, an amount which would have gone a long way in seeing them through the depression of 1921.

The same state of affairs reflected by Australian conditions has been world-wide. Mining in the past has been one of our staple industries; the industry, in fact, which laid the foundations of the country's commercial

importance, and has added millions to the wealth of the empire. It can truly be said that great expansion is possible. The gold yield may not reach the high figures of a few years ago when the Bendigo, Charters Towers, and Kalgoorlie mines were at their zenith, but there are other valuable mineral assets which must be developed to meet the needs of industry by the aid of science.

It is impossible to do more at the date of writing than to give an estimate of the gold yield for 1921. The production will be approximately 714,500 fine ounces, as shown in Table I.

TABLE I. AUSTRALIAN GOLD PRODUCTION, 1920–1921

	Actual Gold Yield, 1920	Estimate for 1921
New South Wales	48,907	50,000
Queensland	115,230	50,000
South Australia	1,697	500
Tasmania	6,246	5,000
Victoria	168,979	98,000
Western Australia	617,842	510,000
Northern Territory and Papua	3,642	1,000
Totals	962,543	714,500

Gold Premium Keeps Mines Going

Had it not been for the formation of the Gold Producers' Association, with the approval of the commonwealth authorities, to export "new" gold only, there would have been few if any gold mines working in 1921 in Australia. As it is, there is hardly a mine making a reasonable profit over and above the amount received as a premium; and it will therefore be seen that the future of the industry depends on two alternative factors—the reduction of costs represented by labor and supplies to something like pre-war values, and the maintenance of the present premium on gold. Permission to export was originally granted for six months only, but extensions have been granted from time to time.

During the half year ended June 30, 1921, the average London price for fine gold was £5 10s. 8d. per oz. The association sold during September (including local sales) 99,648 oz. of standard gold at an estimated net price of £5 2s. 3d. per oz., which is equal to £5 11s. 6d. per oz. fine. Table II shows the amount of the distribution of premium made in respect of the half year ended June 30, and the total sum distributed since the formation of the association in April, 1919.

TABLE II. TOTAL OF AUSTRALIAN GOLD PREMIUMS

State	Half Year Ended June 30, 1921 Amount			—Total to Date— Amount		
Western Australia	£274,856	12	1	£1,874,363	15	1
Victoria	63,387	15	4	420,877	11	8
Queensland	73,585	12	11	382,918	3	3
New South Wales	26,826	3	1	126,056	8	3
Tasmania	2,892	4	7	17,119	10	4
Papua	1,469	2	5	7,320	7	3
South Australia	1,619	0	2	6,058	18	4
Northern Territory	.....	..	.	19	12	7
Totals	£444,636	10	7	£2,834,734	6	9

As illustrating the altered conditions of gold mining in Australia, the following statement made by the chairman of directors of the South Kalgurli Consolidated, one of the Golden Mile group in Western Australia, is typical. He said:

"Looking back to pre-war days, I direct attention to the vast change that has come over mining activities. Then expenses ranged all told in the neighborhood of 20s. a ton; now they are over 32s., an increase of 60 per cent. During the present year these costs must go up still further in consequence of the award of the Arbitration Court, which came into force on Jan. 1 last. This award meant an increase in the cost of working the South Kalgurli Consolidated, so far as the directors could make out, of roughly £1,500 a month. This change, which even took the workmen themselves by surprise, spelt ruination to most, if not all, the Kalgoorlie mines, and its continuance threatened to lead to the abandonment of the field."

In the face of such a statement it requires pluck to undertake the development of new mines, and it is really surprising to see the number of new companies being registered.

The award referred to increased the minimum wage in Western Australia from 12/6 to 16/— for surface men and 16/6 for underground men, skilled labor being advanced in proportion. For Sunday work and overtime, double pay is allowed, as well as fourteen days' holiday on full pay each year.

Necessity of Improving Methods

The whole blame for the present state of affairs at Kalgoorlie cannot be laid at the door of the employees. With few exceptions little new equipment and few improved methods have been introduced during the past decade, and if any attention has been given to this aspect by the managements no details have been made public. One direction in which there would appear to be considerable room for economy is in the erection of a modern central power station. The nearest coal field is at Collie, about 500 miles away. Consequently wood is the only fuel for power generation. The position today is that nearer supplies of the local timber (eucalyptus) have been cut out for a radius of about eighty miles. Two companies, the W. A. Goldfields Firewood Co., and the Boulder Firewood Co., operate many miles of 3 ft. 6 in. tramways, and both are extending their lines. This, with the natural increase in wages of the employees of the timber companies, has been reflected in the cost of fuel to the companies. When it is realized that thousands of horsepower units of gas producers burning wood in long lengths are at work in Australia and that these plants are guaranteed to consume a maximum of 2½ lb. of fuel per hp.-hr. as against anything from 8 to 24 lb. when used in a boiler furnace, it is surprising that the use of gas engines has not been seriously considered.

The tributing, or leasing, system is a popular method, adopted by some companies, of working their mines without running the risk of losing money. Groups of men are given certain sections to work, the company taking a royalty on the gold produced and also making a profit on the treatment of the ore in its mill. Several of the large companies have let their properties to tribute altogether, and some excellent results have been obtained from ground considered by the companies not worth working on their own account; others, again, have not been so fortunate. One Golden Mile lease in particular has by the considerable number of rich returns obtained by tributers been rather a surprise, causing one to wonder at the inadequacy of early-day sampling—the tributes being mostly in the upper reaches of the mines.

Table III shows the ore treated and gold production of the principal Kalgoorlie mines for the first nine months of 1921.

TABLE III. JANUARY TO SEPTEMBER, 1921, AUSTRALIAN TONNAGE OF ORE AND GOLD PRODUCTION

Kalgoorlie Mines	Tons	Fine Ounces
Associated	43,862	13,460
Associated Northern	3,570	4,591
Golden Horseshoe	85,919	40,578
Great Boulder Prop	77,368	50,123
Great Boulder Perseverence (a)	36,183	35,542
Ivanhoe	112,098	44,573
Kalgurli (b)	17,884	8,668
South Kalgurli Consolidated	57,820	23,505
Lake View and Star	39,190	11,310

(a) Tributers. (b) Seven months.

Statistics available show that the output of the Tasmanian mines for the twelve months ended June 30,

1921, was valued at £1,071,903, a decrease of £530,139 compared with the preceding year. The principal decreases were: Tin, £203,149; copper, £56,872; silver, £38,886; scheelite, £29,702; and wolfram, £20,440.

At the time of writing, with the exception of Mount Lyell, practically all the West Coast mines, including the Mount Bischhoff, North Farrell, Magnet, the Renison Bell tin group and the Zeehan silver producers, are at a standstill awaiting a turn in the market. [Later: In November representatives of Continental smelters resumed buying Tasmanian silver lead ores.]

The Queensland government in the last year or two has embarked on several state-owned mining ventures, but it cannot be said that any great success has yet been attained. The lead and copper smelting works taken over from the ill-fated Chillagoe company showed a loss during the twelve months ended June 30, of £49,450. The total indebtedness of the smelters to the government on June 30 was £292,212.

Another of the state treatment works is the Irvinebank tin smelter. The loss for the year totaled £18,307, and this, with the total of £10,643 for the previous year, gives a total loss of £28,950 since the works were taken over in October, 1919. The plant has been closed down owing to the low price of tin.

During 1920, Chillagoe treated 27,457 tons of copper ores and 20,859 tons of silver-lead ores. The copper produced is being stacked pending the recovery of the market. The tin smelters at Irvinebank produced 250 tons of tin in 1920. The experience with these works and also at the state batteries, of which a number are operating on various fields, shows that the promises of the small producer to keep the plant going if erected are rarely fulfilled, making it necessary, as has always been the condition with privately controlled treatment works, for the owners to have a mine or mines of their own.

Government Producing Arsenic

The production of arsenic is another field into which the government entered early in 1918. At this time arsenic was in large demand and the market price was high. Large quantities are used in Queensland for combating the prickly-pear pest, and it is being supplied for this purpose at £23 per ton, although, as the auditor general recently pointed out, the cost of production is approximately £50. In consideration of the fact that the net loss for the year was £4,797, and the aggregate loss £46,802, it would appear that the government would have been better advised, and would have adhered more to the functions of a government, had it subsidized private producers.

The state is also becoming heavily involved in its coal mines at Bowen, Baralaba, and Styx River, but undoubtedly some steps were necessary to prove the resources of the state in this field. The whole of Australia in the past has been too dependent on the coal fields of New South Wales.

Little is being done so far with the iron and steel works to be erected at Bowen; the total expenditure aggregates only £16,286. It is understood that a part of the recent loan raised in New York will be devoted to the establishment of the iron works, but there are so many demands for money, as can be realized in part by the foregoing, that it is unlikely that any considerable amount from that loan will be forthcoming.

Western Australia has an extensive state battery system which is in the nature of a subsidy to encourage mine development. The output of gold from these batteries from the time of inception to July 31, 1921, is as follows:

Tons of ore milled, 1,303,138; production by amalgamation, £4,457,994; by sand treatment, £654,708; by slime treatment, £218,414, and by treatment of residues, £9,353. Total gold produced was valued at £5,340,471. At the tin-dressing plants the tonnage of tin ore treated amounted to 80,067, the production being black tin valued at £92,420 and residue treatment, £572.

The Cloncurry copper field, embracing the Mount Elliott, Hampden-Cloncurry, Mount Cuthbert, and Mount Oxide companies, besides many smaller camps, is stagnant, with no prospect of a resumption until the market price of copper improves.

Mount Elliott District Rich in Copper

Mount Elliott made an effort to interest American capitalists, and experts were sent out to investigate, but evidently the negotiations failed. Although some of the mines are approaching exhaustion, the area is undoubtedly one of the richest copper fields of the world. The suggestion has been made and is worthy of more mature consideration that the three large companies should amalgamate and erect treatment works in a central situation, and this may yet be done.

Queensland's mineral production (other than gold, coal, or precious stones) for the first half of 1921 shows a total value of only £176,290, as compared with £1,102,037 for the same period in 1920. Copper accounted for about two-thirds of this decrease.

The large plant erected at Risdon, near Hobart, by the Electrolytic Zinc Co. reached the producing stage during the last quarter the 1921, but its contribution for the year will not be large. The company has concluded an arrangement with the British Board of Trade for the treatment of 750,000 tons of Broken Hill zinc concentrates, and in addition has contracts giving it a percentage of the current output of the Broken Hill mines. It was recently reported that the British zinc smelters are undertaking treatment of concentrates from the same source, so accumulated stocks should gradually be depleted.

Development in Papua Promising

In the commonwealth territory of Papua, the New Guinea Copper Co., in which Hampden-Cloncurry investors are largely interested, appears to have a promising mine, the ore reserves standing at 235,000 tons, containing 10,750 tons of copper and 2,900 oz. of gold. The original proposal to erect a smelter at the mine has been dropped, and the ore will now be shipped to Australia. The railway and shipping facilities at the port are completed. The factor which makes it possible to work the Papuan mine, though others on the mainland are lying idle, is undoubtedly the supply of cheap native labor.

The Hampton Plains gold field, in Western Australia, which came to the front in 1920, has failed to maintain its position, and now more interest is being centered on the Ives and Monger groups beyond. A battery at Mount Monger is treating prospectors' parcels, and this is of considerable help to the field, doing away with the necessity of sending to Kalgoorlie.

Wallaroo and Moonta, in South Australia, after being shut down for several months, resumed work in August, 1921, wages being reduced to 10/6 for the lowest paid grade of labor. The rates are to be revised when the selling price of copper reaches a figure of £78 per ton.

At Bendigo the Amalgamated Gold Fields Co. is operating mines in the central portion of the field on the Garden Gully, Sheepshead, and Derby lines. Of the mines being worked by this company, the Carlisle and Unity are working spurs at the 1,235 level, with profitable yields from a large tonnage; at the Constellation five feet of payable spurs at the 622 level are being mined; at the Hercules, prospects are improving. The quarterly yield (September) was 3,552 tons for 1,070 oz. Development work is in progress at the Virginia mine, below the 1,440 level, where payable gold was formerly obtained. At the Monument Hill, Great Northern, Londonderry, and Ironbark mines fair yields are being obtained. Bendigo A. I. Company (New Moon line) crushed 3,565 tons yielding 1,113 oz. and is being actively developed. Lansell's Little 180, Lansell's North Red, White & Blue, and Lansell's Needle are developing, the crushings for January to June, 1921, from the latter being 6,202 tons, yielding 1,764 oz. The New Red, White & Blue mine crushed 4,759 tons, yielding 4,028 oz. for the first half of 1921.

At Ararat, the Langi Logan group of deep alluvial mines are opening up a wide lead. The New Langi Logan mine yielded 1,798 oz. of gold from 1,550 fathoms of wash during the first half of 1921, making a total yield of 14,054 oz. from 11,003 fathoms from this mine. The Langi Logan South mine for the same period of 1921 yielded 1,624 oz. of gold from 1,725 fathoms.

At Daylesford, the Ajax and Ajax North are the chief mines working. From January to June, 1921, the Ajax mine yielded 660 oz. from 2,060 tons and the Ajax North mine 1,685 oz. from 6,102 tons.

At Heathcote the Costerfield Gold & Antimony Co. is considering the erection of smelters to deal with antimony concentrates in the state. In the Gippsland district, the A. I. mine, Gaffney's Creek, is developing at No. 7 and 8 levels, the shaft now being 1,330 ft. deep. The yield for the first half year of 1921 was 3,694 tons, for 2,851 oz., making a total of 76,220 tons, yielding 63,136 oz. of gold.

Petroleum and Miscellaneous Minerals

Oil is the magic road to wealth if the statements of the promoters of dozens of companies are to be believed, and the country is being overwhelmed with oil experts (?) of all shades. Most of these alleged oil finds are "duds," and in several states the geological survey officials have found it necessary to speak plainly and even to insist that overenthusiastic promoters should not make knowingly misleading statements. At the same time it is believed sufficient evidence does now exist to allow it to be said that the indications in the northwest of Western Australia and probably through the northern part of Australia to Queensland, where natural gas exists in large quanities at Roma, are sufficiently favorable to warrant prospecting on sound lines.

Among other minerals there has been considerable activity. The iron and steel industry has given some encouragement to the mining of manganese, fluorspar, and other metals and minerals. Industrial activity has stimulated the demand for cement, baryta, gypsum, asbestos, ocher pigments and clays. The rare-metal mines are practically all closed, being unable to produce at present prices. The Tasmanian osmiridium deposits keep a number of men at work, but at recent low rates, few are earning more than wages. For the first half of the year, 905 oz. was produced, valued at £26,539. What appears to be a valuable deposit of cobalt is being developed on the Cloncurry field by W. H. Corbould, of Mount Elliott. Several parcels were dispatched to England for treatment, and the results were sufficiently favorable to warrant the erection of a treatment plant.

Gems, principally sapphires and opal, are produced in Australia, the former in New South Wales and Queensland and the latter on the old-established White Cliffs field, in New South Wales, and on the comparatively new Stuart Range field, in South Australia. Mica also occurs in payable quantities in the McDonnell Ranges, South Australia, near the center of the continent. Water and transportation difficulties have to be overcome. A promising deposit has also been opened up in the Cloncurry district, Queensland, and several parcels sent out have found a ready market in New South Wales and Victoria.

German Potash Again a Market Factor

The disturbance in the fertilizer industry due to the slump in prices of farm products, resulting in delayed payment for fertilizer stocks already purchased, created a below-normal market for potash during 1921 amounting to an almost total failure. Domestic potash producers shut down their plants early in 1921 and have not since operated.

American fertilizer manufacturers have recently concluded a contract with German potash producers for 75 per cent of their estimated needs in 1922 and for the remaining 25 per cent have closed contracts with the French potash producers. Despite the fact that two of the domestic producers offered the fertilizer interests their hold-over potash at the German price, they were unable to sell.

Apparently, American potash interests are out of the market for the season and face extinction unless protection is given them in the near future. The tariff bill, now before the Senate, provides for a temporary tariff starting at 50c. per unit for the first two years and diminishing to nothing at the end of five years. The larger American producers appear to be willing to continue and even to put additional money into betterment if the protection asked for is granted.

Though the future of the domestic producers is uncertain, they are in a strategic position to control fertilizer markets adjacent to their producing units by entering into the manufacture of commercial fertilizers. Apparently no movement to accomplish this object as yet has been initiated.

Imports of potash for 1921 were much lower than those of 1920, amounting to approximately an equivalent of 25,000 tons of K_2O for the first ten months of the year. Imports for 1922 will be as great as, if not greater than those of 1920, during which an equivalent of 225,000 tons of K_2O was imported.

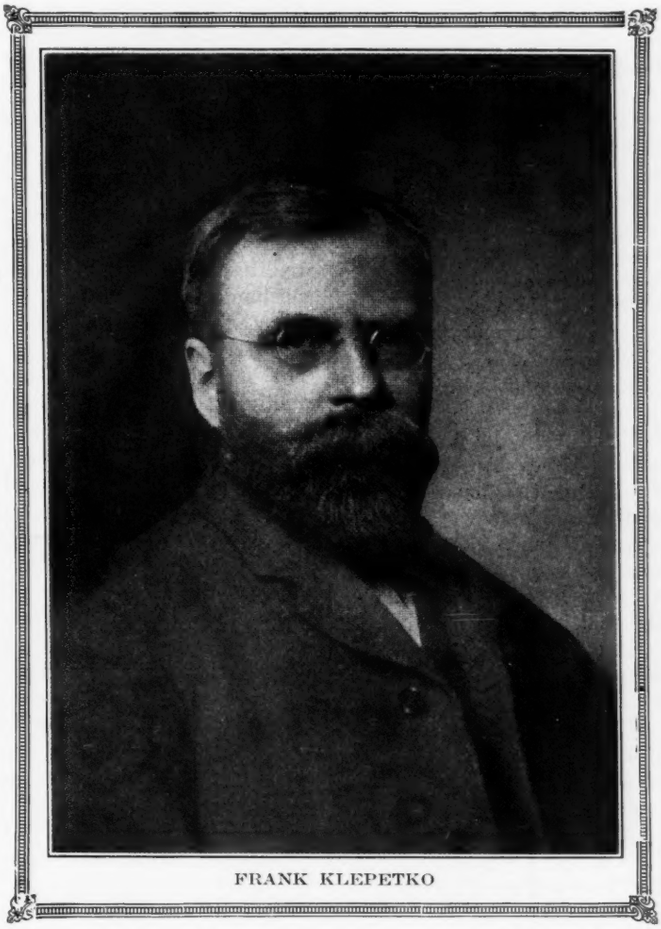
Testing Electrolytic Production of Antimony

At the Northwest Experiment Station of the U. S. Bureau of Mines, at Seattle, Wash., the electrolytic extraction of antimony from low-grade antimony ores and from gold ores containing antimony has been studied. Calcium polysulphide proved the cheapest and best alkaline-sulphide leaching agent for antimony ores, whereas sodium sulphide proved to be the best for gold ores containing antimony. Some Western and Alaskan ores are of these types and have proved refractory to usual methods of treatment.

Mining Engineers of Note

Frank Klepetko

AMONG the group of engineers who have been and are actively associated with copper mining and metallurgy none stands out more prominently than Frank Klepetko. Entering his work at a time when copper metallurgy received the impetus that has been followed by a continuous period of development, he soon acquired an important place as an authority in copper smelting and refining. He was born in what is now Czechoslovakia in 1856. His parents came to the United States in 1867, and settled in Cleveland, Ohio, where he attended the public schools, being graduated from high school in 1875. He obtained his degree of Engineer of Mines at the School of Mines, Columbia University, in 1880. In common with many men prominent in the copper industry today, Mr. Klepetko began his service in the Lake Superior "Copper Country." From 1880 to 1882 he was employed by the Conglomerate Mining Co., of Michigan. He then entered the employ of A. S. Bigelow, of Boston, Mass., and his associates, in their various mining and smelting enterprises in Michigan, the principal of which were the Tamarack, Osceola, and Kearsarge mining companies, the Hancock & Calumet R.R., and the Dollar Bay Smelting Works. But the call of the West, which has weaned many away from the first fields of their endeavor, was strong, and in 1891 he was transferred by Mr. Bigelow to Montana, to complete the construction of the Great Falls smelter for the Boston & Montana C. C. & S. Mining Co., and, when this was finished, he remained there to superintend the operation of the plant. Many difficulties had to be overcome and many problems solved to bring the plant to its present high degree of economy and efficiency. Among these may be mentioned the following: The improvement of wet-concentration methods for ores, effecting higher savings; development of a satisfactory and economical calcining furnace; the gasifying of high-ash coal; the application of gas to reverberatory smelting of copper ore calcines; the development and application of the blast furnace to the semi-pyritic smelting of raw copper ores, including their mechanical charging; the development of the direct converter process for copper mattes—i.e., the bringing of molten copper mattes directly from the furnace to the converter, without intermediate solidifying and remelting; the improvement of the parallel system of electrolytic copper refining, and the development and improvement of mechanical appliances in all departments. These improvements placed this plant so far ahead of similar plants that it became a model property, and its improvements were copied by copper metallurgists generally. In 1896 Mr. Klepetko was appointed general manager of the Boston & Montana and the Butte & Boston mining companies, which later were absorbed by the Anaconda Copper Mining Co. In addition to these duties, he was appointed, in 1900, manager of the Anaconda reduction works. In 1902 he resigned his active Montana positions to take up consulting work in New York, and he has been so employed ever since. Under his supervision and management, the great copper smelting works at Great Falls, Mont., the Utah Consolidated smelter at Salt Lake City, the Michigan Smelting Co.'s smelter at Houghton, Mich., the Cerro de Pasco smelter in Peru, and the Anaconda smelter of the Anaconda Copper Mining Co. have been constructed. When Mr. Klepetko left the Anaconda smelter, it was considered one of the best, both from a metallurgical and an economic standpoint.



FRANK KLEPETKO

While in Peru for the Cerro de Pasco Mining Co., Mr. Klepetko became convinced that there were splendid opportunities for profitable mining in that country, and he acquired large mining interests there.

Mr. Klepetko has always been a man of great energy and believes in being personally on the job. For over a year he has been in Peru supervising the work being done at plants in that country in which he is interested. He is a member of the Columbia University Club, the Engineers' Club, the American Institute of Mining and Metallurgical Engineers, the Institution of Mining and Metallurgy, the North of England Institute of Mining and Mechanical Engineers, and the Montana Society of Engineers.

HANDY KNOWLEDGE

Neighborly Chats With the Foreman

Loyalty to the Company

BY DUNCAN MACGREGOR

Written for *Engineering and Mining Journal*

Sore again, Jim! I heard you cussing the mine, the "super," and the universe the other day, and I decided that I would tell you a few things after your safety valves had seated themselves. When a locomotive boiler is blown out, they take it to a convenient place and the steam raises a hurra with the sticks and stones and dust until all the poison is out of the boiler. It would create havoc and no end of work if it were blown off in the round house, and so would your cussing if the "super" and the directors and stockholders had been about. You used more wisdom than I thought you had when you broke loose the other day. It's a good plan to blow off where it won't hoist you out of your job.

To get down to business. Have you ever thought how it is that your job goes on and on and the pay check comes in as regularly as the calendar? First, it is by grace of the mine; second, it's due to the fact that a certain group of men found the money to put into the plant, equipment and the development to make a go of the mine. They picked the directors and the directors picked the "super." The "super" has to keep all the wheels going and has troubles of his own, and naturally he wants you to take care of your own. The stockholders expect expenses to be met by proceeds and also want a little velvet now and then. A pretty large part of the proceeds of the mine goes to you, your men, the "super" and others, who get their three squares and a home out of their work.

Work is a good thing, and most of us don't appreciate it until we have stalked a job for a month or more without finding a thing to shoot at. Good honest returns are needed on the part of everyone to make things go. Loyalty is at the bottom of every success, and earns its reward in the pay and in the satisfaction of seeing the company grow.

You have a very definite part to play. In a measure you are in a position of trust. It is up to you to get a proper accounting for labor time, for that represents money outgo, and unless reasonable performance is secured, the ship will go on the rocks. Prevention of waste in supplies, powder, tools, and power is another way in which you can show your loyalty. The accumulated saving within a year by a little extra watchfulness on your part may put a dividend upon the board and encourage more capital to go into mining enterprises.

You are one of the props of the "super," and in proportion as you do your share and hold up your end you will clinch your own job and give the stockholders a run for their money. Facing the other way, it's up to you to make work a pleasure for your men. Loyalty to them consists in having and showing faith in them. You are getting restless, I see, and I'm not going to sermonize on this, but just let me suggest that you go down into the mine like a boy rushing out upon the first snowfall of the season, and the men will catch your spirit and reflect it, and your troubles will disappear.

McLellan Rock Drill Bit

BY H. A. KEE

Written for *Engineering and Mining Journal*

Experiments at the Kerr Lake property, at Cobalt, Ont., have proved of value in procuring more efficient rock-drilling footage, particularly during the last year, by materially altering the design of the company's standard four-point cross-bit. These changes are essentially the result of a machine-drilling contest held at Cobalt on July 2, 1921.

Two teams entered from the Kerr Lake with thirteen other entries. In the course of experimenting and practicing for the competition, it became apparent that changes were necessary in the bit, to procure maximum drilling speed in the contest. W. P. McLellan, master mechanic, and others of the mine staff and employees assisted in working out the design of the bit used, which is referred to here as the McLellan Kerr Lake bit. The Kerr Lake teams experienced little difficulty in drilling the two deepest holes in the given fifteen minutes, using a No. 88 Rand Leyner water drill, although the machine used was not the best drilling No. 88 Rand Leyner water drill in the contest. It will therefore be apparent that the exceptional results were due not only to the efficiency of the miners and good work of the machine but also to the diameter, gage and temper of the bit, which drilled a perfectly free hole in exceptionally hard-surface Cobalt conglomerate without the slightest difficulty, although the first three steels had only $\frac{1}{16}$-in. gage variation in 24 in. run.

We found during recent years, by studying conditions closely and experimenting considerably with various types of water machines in the hard lower contact of the Keewatin and diabase formations, that the customary practice of using drill bits $\frac{1}{8}$-in. gage variation per foot of run is entirely unnecessary, and with the McLellan Kerr Lake bit on $1\frac{1}{8}$-in. hexagon hollow steel the diameters of bits have been gradually decreased from $2\frac{3}{8}$ in. to $1\frac{1}{2}$ in. on 1-in. hexagon hollow 2-ft. starters, used to collar 7-ft. holes. The company is now successfully using $\frac{3}{64}$-in. variation per foot of run on steel from 2 to 8 ft. long, in underground operations. If it were possible to gage more closely with the drill sharpener, the steel could be successfully used with even less variation in Cobalt conglomerate and in the Keewatin and diabase formations.

By boring a smaller hole greater efficiency is obtained from the $1\frac{1}{4}$ and $1\frac{1}{8}$-in. explosives, as larger holes allow the explosive to buckle when placed in the hole, and the result is at least one air gap to each stick of explosives used, which condition, with the best possible tamping facilities, does not give the desired results. It is probable, too, that $1\frac{1}{8}$-in. powder well tamped in proper-sized holes drilled in average ground will produce results as good as can be obtained with $1\frac{1}{4}$-in. explosives, and this would prove a further saving.

We therefore appreciate the benefits of using a bit of smaller diameter and of improved design when drilling efficiency is increased from 20 to 40 per cent, with about the same advantage in the results obtained with explo-

sives, and a material advantage is indicated, not only in the breakage of steel but also in repairs to machines. Such advantages are due to the use of drill bits which cut freely with the minimum amount of vibration and steel-to-rock resistance, thus eliminating unnecessary binding and reaming conditions.

We always appreciated the necessity of properly designed and tempered reaming angles for reciprocating piston drill boring, but in operating with Leyner and other water-stoper types we believe that best results can be procured with the minimum amount of resistance and reaming. This may be accomplished by using the tempered, cutting edges of the bit and gage corners only to cut or chip out the hole, instead of undertaking to guide the steel with the reaming edges of the wings designed with a slight degree of taper.

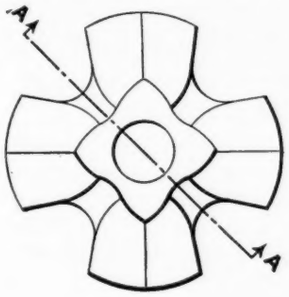
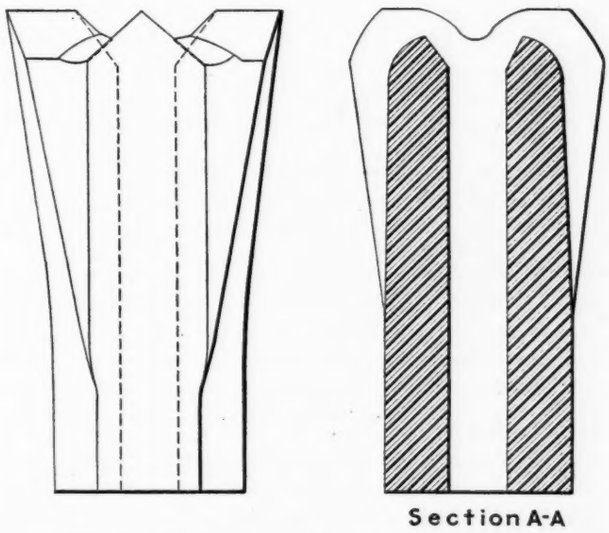


FIG. 1. McLELLAN KERR LAKE ROCK DRILL BIT



With the McLellan Kerr Lake bit, which may be used as a detachable bit, a core is left in the bottom of the hole and large pieces of this core break off as the four individual chipping chisels cut out the channel around the core. Then these coarse ($\frac{1}{8}$ to $\frac{3}{8}$ in. in size) particles of core are, in operation, blown out of the hole by the usual water and air pressure. The lower portion of this center core positively guides the drill bit by inner bearing or contact of bit and core, leaving the essential outer corners of the bit free for maximum boring, with a minimum amount of wear. All of this is indicated in Fig. 2.

It may be said that slightly tapered or nearly parallel wings are necessary to keep the steel from cutting out of line, as is undertaken with the standard double-taper bit, but we believe that extreme variation in gage and large diameter bits is more often the reason for running or binding holes, and, in average hard ground, with a minimum variation in gage and small bit diameter, these difficulties may be eliminated.

The McLellan four-point cross-bits are made with heavy wings about $\frac{5}{16}$ to $\frac{3}{4}$ in. thick, the pitch or taper of which is 7.5 deg., and finished with an 8-in. circle rounded fillet, which design allows ample diagonal corner clearance as compared with diameter of cutting edges of bits which are made with 92 to 100 deg. angle, depending on the character of ground to be drilled.

As indicated by Fig. 3, it will be noted that the McLellan punch, when used separately from the sharpening dollie, is a double-tapered tool, which, without sticking in or splitting the steel, makes the walls of the hole in the bit the proper shape to assure higher cutting efficiency.

As previously stated, this center core acts as a positive guide for the drill bits, making it possible to drill perfectly free-running holes 12 to 13 ft. in the hardest Cobalt conglomerate with water machine and hollow steel, and this has been done with a gage variation of from $\frac{1}{64}$ to $\frac{3}{64}$ in. per ft., due to the fact that this combination of core guidance and positive rock-chipping bit cuts a perfectly smooth and straight hole in the direction in which it is pointed.

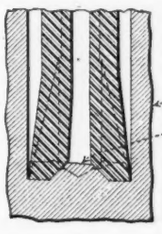

Section through bit and rock showing advantage of enlarged water-outlet in eliminating reaming action on sides of steel
Rock core to here

Fig. 2

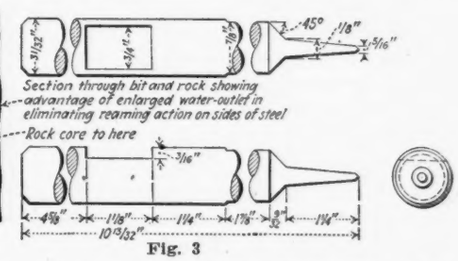


Fig. 3

FIG. 2. SECTION THROUGH BIT AND ROCK SHOWING ADVANTAGE OF ENLARGED WATER OUTLET IN ELIMINATING REAMING ACTION ON SIDES OF STEEL

FIG. 3. McLELLAN PUNCH

We have found, too, that vertical down holes at least 8 ft. deep can be drilled without difficulty with this design of bit by using the same diameter of bit on each steel, but we have not as yet undertaken to drill holes at various angles.

Mine Models of Glass

BY A. J. McDERMID

Written for *Engineering and Mining Journal*

In making mine models of glass the glass can be prepared for tracing in the following manner: First, wash with Bon Ami; then dull the surface by drawing across it a pencil eraser in the places where the lines are to be. Ordinary drawing ink can then be applied successfully by means of a lettering pen, a ruling pen, or a camel's hair brush. This plan obviates the necessity of using oil paints, which require a day or two for drying.

Straightening Track Spikes

BY ROY H. POSTON

Written for *Engineering and Mining Journal*

Underground track spikes may often be used several times if straight enough to be redriven in a new tie. To straighten bent spikes a device may be used consisting of piece of discarded cast iron of suitable dimensions with a hole slightly larger in diameter than the width of the spike. The bent spike is forced through the hole.

THE PETROLEUM INDUSTRY

Petroleum Investigations of U. S. Bureau of Mines

Field work in the Bristow, Okla., oil district is being continued by F. X. Schwarzenbek and J. O. Cable, petroleum engineers of the Bureau of Mines. Considerable difficulty was experienced in obtaining locations and elevations of wells in the Slick field, owing to the rough and woody country in which the field is situated. The southern part of the Slick field is troubled with water and basic sediment in the oil, it costing one company as much as 17c. per bbl. to remove the basic sediment. The various causes of the formation of the emulsion are not definitely known. It is sometimes caused in pumping wells by leaky valves and cups when water accompanies the oil. Gas agitation of the wells may cause water and oil to emulsify. The work of constructing the peg model of the field will probably be started immediately.

Information is being collected for a report to the Secretary of the Interior on the value of natural gas in the Osage Nation in Oklahoma. This report is to be used in redetermining the price basis for the computation of royalty on gas produced, eleven gas leases having been made by the Department of the Interior covering the Indian lands of the Osage Nation. The present basis for determination of royalty is 18c. per 1,000 cu.ft. at the well. Each lease has a clause providing for redetermination of price basis at specified times. On March 16, 1918, the price of gas was established at 18c. per 1,000 cu.ft. for four of these leases, and the price will hold until March 16, 1923. The present price of 18c. for gas for the other seven leases has not yet been redetermined. The new price will hold from Sept. 16, 1921, to Sept. 16, 1923.

D. B. Dow, chemical engineer of the Bureau of Mines, has completed the field work outlined in his study of hazards in the shipping of natural-gas gasoline. The proposed regulations submitted by the Bureau of Explosives allow no gasoline to be shipped in standard cars unless the vapor tension of the product is below eight pounds. The present regulation allows gasoline of ten pounds' vapor tension to be shipped in standard cars. Several tests were made to determine the loss which might be expected, due to weathering gasoline of ten pounds' vapor tension. These tests indicate that the loss will be about 11 per cent.

Work is being continued at the Bartlesville station on the effect of back pressure on oil production. The production of well No. 7 of the Osage Development in Oklahoma has been measured daily under various back pressures. Samples of the fluid produced were taken hourly for several days, and the water and basic sediment content determined. A back pressure of about 25 lb. affected the oil production when the tests were first started, but several months later a back pressure of only 20 lb. affected the same well. Final conclusions as to the effect of back pressures on wells on this property have not been drawn.

The special investigation of water problems in Oklahoma oil wells has as its objects to increase the production of oil on properties that are now producing large amounts of water; to instruct operators in the use of cement as a means of shutting off water; and to determine the source of water and devise means for shutting it off by applying modern engineering methods. The work will be undertaken in the Deaner, Cushing and other fields. R. R. Templeton, petroleum engineer, and R. M. Carr, assistant petroleum engineer, have been assigned to the investigation.

Oil Royalty Taxes of Indians To Receive Adequate Protection

WASHINGTON CORRESPONDENCE

The House of Representatives Committee on Indian Affairs has reported a bill which would authorize the Interior Department to employ competent tax experts to prepare the income tax returns of the Five Civilized Tribes of Indians in connection with their oil royalties. The compensation to be paid these tax advisers would not exceed 5 per cent of the depletion or other allowance secured by them for the Indians. It is said the present returns, which are prepared by the superintendent of the tribes, do not adequately protect the Indians against the payment of excessive income taxes, and, further, that the superintendent has no knowledge of the basis on which the Revenue Bureau fixes depletion.

The superintendent has been computing the taxes on the basis of the actual decrease in production for each current year, taking the per cent of the decrease as the depletion, which, however, has not been allowed by the Government, and additional assessments have been made. The Interior Department has suggested that it use the oil operators' tax returns as a basis for preparing the returns for the Indians owning royalties. The Revenue Bureau declined, on the ground that the returns must be held confidential and also because the operators' returns would not be a proper basis for royalty owners, as the depletion unit of the operator is not determined by the same computation as the depletion unit of the royalty owner. The Indian royalty owner is entitled to revaluation for discovery, but only under exceptional circumstances is the operator entitled to such revaluation for discovery.

Orange Field, Texas, Shows Deeper Sands

SPECIAL CORRESPONDENCE

Attention is again centered on the Orange field (Terry field), in Orange County, Tex. Recently the Humble Oil & Refining Co. completed its No. 5 Chesson well, flowing 5,000 bbl. through a choker from 3,920 ft., or about 300 ft. deeper than the other big wells in the field. Later the sand in the oil cut the connections, and the well ran wild for a time, flowing at the rate of 12,000 bbl. daily. This trouble happened a second time, and the well lately has been flowing at the rate of 25,000 bbl. daily. Fifty new wells are being drilled, and several producing wells will be deepened to the new sand.

Technical Papers

Underground Loaders — A general review of the various types of underground loading devices is given in *Reports of Investigations*, U. S. Bureau of Mines, by C. Lorimer Colburn, "Underground Loading Devices in Metal Mines" (obtainable on request from the Bureau at Washington). The report covers the operation, capacity, construction, and performance of the different types of underground mechanical loading machines and their applications in the various metal-mining districts. A study of the subject is being continued by the Bureau of Mines. The material included in the report covers those machines which are now in accepted use.

Oil—"Oil Possibilities of the Holbrook Area in Northeast Arizona" has recently been published by Dorsey Hager, geologist and petroleum engineer. This report covers the findings and deductions of the area extending from the town of Holbrook, Ariz., as a center, to the Zuni Uplift, in New Mexico, 100 miles east; to the Grand Canyon, 125 miles northwest; to the Apache Uplift, 70 miles south; and to the San Juan (Utah) area, 150 miles north. The area of immediate interest for oil possibilities lies within a radius of 40 miles of Holbrook.

Petroleum in Colombia — "Geology and Oil Resources of Colombia; the Coastal Plain," is the title of a seventeen-page article in *Economic Geology* for November. (Lancaster, Pa.; price, 65c.). The writer, Elfred Beck, spent six months in Colombia in the summer of 1919 exploring a large tract of land near the Caribbean coast. The paper includes a detailed account of the geology in the vicinity of the San Andres concession, a reconnaissance report of the remaining area explored, and comparisons with the geology of Colombia as a whole.

Cedar Mountain, Nev.—Bulletin 725-H of the U. S. Geological Survey, Washington, D. C., twenty-one pages, obtainable on request, is entitled the "Ore Deposits of Cedar Mountain, Mineral County, Nevada." Cedar Mountain, in the western part of the state, contains the Simon silver-lead district, which is the chief center of interest, and the Omco gold district. The bulletin is confined to a description of the geology of the region.

The Joplin-Miami District—The mining edition of the *Joplin Globe* (published at Joplin, Mo.) is a sixty-six page supplement containing much information of value to any one interested in the zinc-lead mining industry of the Tri-State district. Zinc for roofing purposes; better selling methods for ore producers, and local milling methods are among the subjects discussed. A mining directory and two maps are useful features.

Bureau of Mines—The eleventh annual report of the Director of the U. S. Bureau of Mines, for the year ended June 30, 1921, is now available on request to the Bureau at Washington, D. C. It is a pamphlet of 133 pages describing the work carried on during the year.

Canadian Mining in 1920 — "Summary Report, 1920, Part D" of the Canadian Department of Mines, Ottawa, Ont., obtainable on request, includes discussion of the "Nipigon-Schreiber District, Ontario"; the "Geneva Map-Area, of the Sudbury District, Ontario"; the "Paleozoic Stratigraphy of Pagwachuan, Lower Kenogami, and Lower Albany Rivers, Ontario"; the "Oil Possibilities of Manitoulin Island, Ontario"; the "Brockville-Mallorytown Map-Area, Ontario"; and an extended paper on the "Fluorspar Deposits of Madoc District, Ontario,"

Cyanide Precipitate Melting — Tests made on the melting furnaces of the Cia. de Real del Monte y Pachuca, to determine the approximate dusting and volatilization losses during the melting of the precipitate, and the volatilization loss during air refining of the resulting doré bullion, are given in a five-page paper in *Mining and Metallurgy* for January. (29 West 39 St., New York; price, $1.)

Oil in Oklahoma—Bulletin 726-F of the U. S. Geological Survey, Washington, D. C., twenty-five pages, obtainable on request, is entitled "Geologic Structure and Oil and Gas Prospects of a Part of Jefferson County, Oklahoma." Recommendations are made as to the most likely places for drilling.

Mining in South Dakota — The "Thiry-first Report of the State Inspector of Mines for South Dakota," for the year ended June 30, 1921, obtainable on request to the State Inspector of Mines, Lead, S. D., is a twenty-three page pamphlet discussing briefly developments among the mining companies for the year, together with a list of accidents and a directory of the mines of the state.

Miners' Almanac—The U. S. Bureau of Mines, Washington, D. C., has issued the 1922 edition of the "Miners' Safety and Health Almanac," obtainable on request to the Bureau. The book contains fifty-three pages of good advice mingled with the customary almanac tabular matter.

Mining in California—A report by the State Mineralogist on "Mining in California in 1920" has recently been issued by the California State Mining Bureau, San Francisco, Cal. It gives condensed summaries of activities in the various mining districts of the state.

Technical Education — Bulletin 152 of the Mining and Metallurgical Society of America (115 Broadway, New York City) contains a twenty-five page discussion of the report of the Committee on Technical Education.

Mineral Resources—Recent publications in the "Mineral Resources" series, issued by the U. S. Bureau of Mines, Washington, D. C., obtainable on request, include: "Gold, Silver, Copper, Lead, and Zinc in Montana in 1920," twenty-four pages; "Concrete Stone and Concrete Blocks in 1920," six pages; "Talc and Soapstone in 1920," thirteen pages; "Gold, Silver, Copper, Lead, and Zinc in Arizona in 1920," twenty-six pages; "Gold, Silver, Copper, Lead, and Zinc in Utah in 1920," twenty-three pages; "Barytes and Barium Products in 1920," eleven pages; "Gold, Silver, Copper, Lead, and Zinc in Nevada in 1920," twenty-nine pages; "Gems and Precious Stones in 1920," four pages; "Zinc in 1920," seventeen pages; "Manganese and Manganiferous Ores in 1920," thirteen pages; and "Gold, Silver, Copper, Lead, and Zinc in Idaho and Washington in 1920," thirty-one pages.

Organizing Recreation — "Important as it is to organize and direct the hours spent in industrial employment, it is equally important to provide for wholesome and revivifying amusement in the worker's leisure time." How the Ingersoll-Rand Co. has done this is described in a twelve-page liberally illustrated article in *Compressed Air Magazine* for December, 1921. (11 Broadway, New York; price, 35c.)

Magnetic Concentration—The Minnesota School of Mines Experiment Station, Minneapolis, Minn., has issued a comprehensive 138-page pamphlet, Bulletin No. 9, entitled "Magnetic Concentration of Iron Ore." The subject is attractively presented, and discusses the matter from the theoretical, experimental, and commercial standpoints.

Milling Zinc Ore—"Milling Methods in the Tri-State Zinc District" is the title of a fourteen-page bulletin issued by the U. S. Bureau of Mines, Washington, D. C., in the *Reports of Investigations* series, No. 2,314. It may be obtained on application. Most of the paper is devoted to a discussion of laboratory jigging work on locked grains of blende and flint. Some comments are made on the general milling practice of the district.

Mining at Howe Sound, B. C.—The mining practice at the Britannia mine, Howe Sound, B. C., is described in an eleven-page paper in the January issue of the *Bulletin* of the Canadian Institute of Mining and Metallurgy, Drummond Building, Montreal, P. Q. The veins or lodes standing at an angle of approximately 72 deg., with a width of 10 to 70 ft., and having fairly strong walls, lend themselves most economically to the overhand shrinkage stoping system.

Magnesite — *Economic Geology* for December, 1921 (Lancaster, Pa.; price, 65c.), contains a seventeen-page paper by H. C. Boydell on the magnesite deposits of Eubœa, Greece. The article is devoted entirely to the descriptive and economic geology of the deposits.

ECHOES FROM THE FRATERNITY

R. M. Linton Elected Chairman of New York Section A.I.M.E.

Classification of Mining Methods Considered—Dr. H. M. Payne Talks on Conditions in Mexico at Monthly Meeting

Mexico is just as safe today as the United States, and there is less of a crime wave there than here, according to Dr. Henry Mace Payne, who recently made an economic survey of the country. Dr. Payne briefly reviewed the situation existing across the border, in an address, illustrated by lantern slides, at the monthly meeting of the A.I.M.E. at Machinery Club on Feb. 8. As he sees it, conditions south of the Rio Grande are much better than they have been since Diaz, and he expressed his belief that Obregon was a second Diaz.

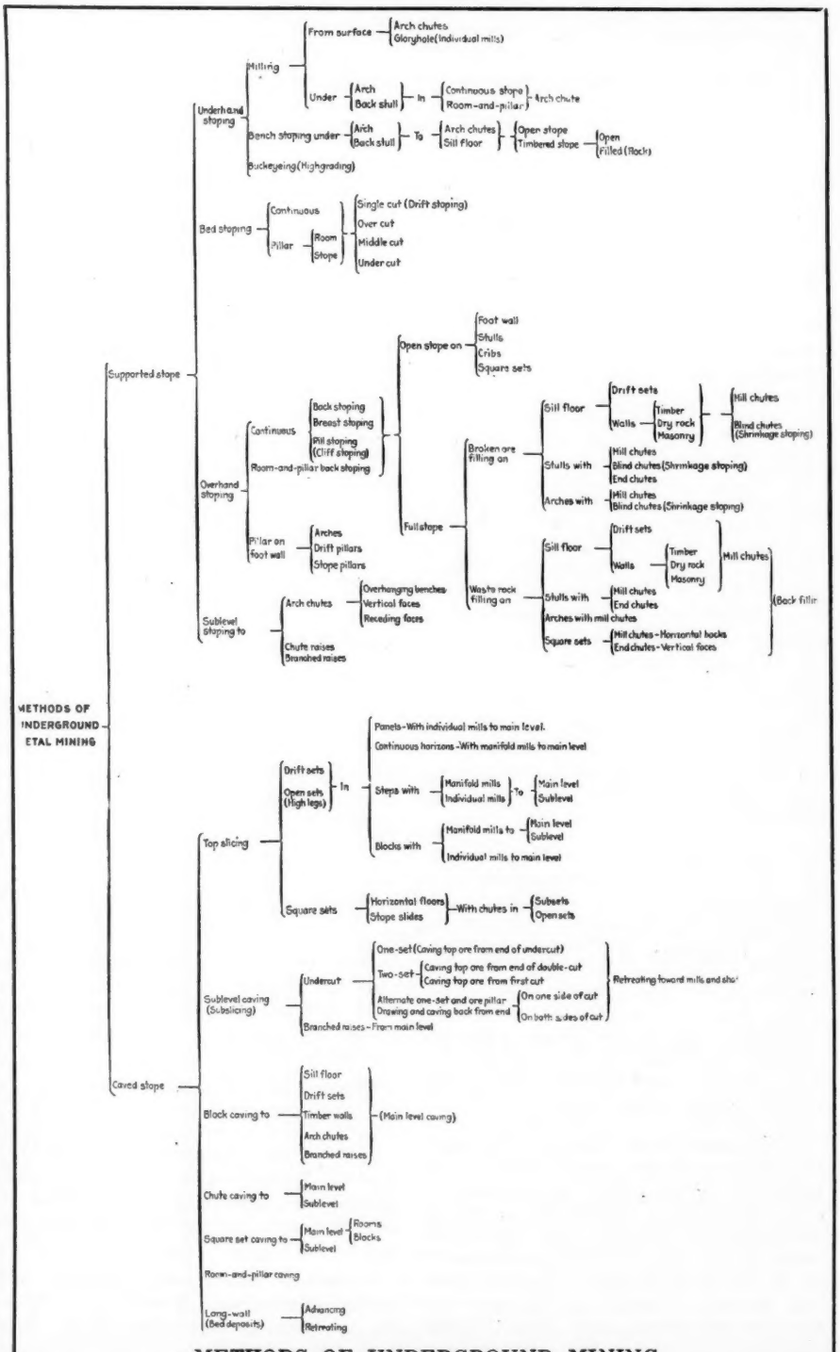
Hard money circulating instead of worthless paper has been an important factor in bringing about the change, according to Dr. Payne. Railroad service in Mexico is improving much more rapidly than most had anticipated. New construction is in progress, and there is much activity in many places, particularly in the states of Jalisco and Nayarit. Bandits are operating in some parts, but that is also true here in New York, Dr. Payne pointed out. The speaker emphasized the difficulty of getting authentic information there, as it would be in any country where 90 per cent of the people were illiterate.

As to why recognition of the Obregon government has been withheld, Dr. Payne hazarded the guess that it was because the interest on the external debt had not been paid. The petroleum situation, he said was only a small factor in the present state of affairs. "Obregon will be recognized," he said, "when the game of diplomacy has been played down to the last card in the deck."

"Classification of Mining Methods" was the topic for discussion on the evening's program. The discussion, however, was rather limited, bearing principally on the diagram drawn up by Prof. F. W. Sperr, of the Michigan College of Mines, which had previously been circulated among the members. Brief comment was made upon this, with here and there a word of criticism, by the speakers, who included Robert M. Linton, Allen H. Rogers and B. Britton Gottsberger. Prof. Robert M. Raymond, of Columbia University, had prepared a chart, giving his own classification, which was thrown on the screen. There was no discussion of Prof. Raymond's classification, as the chairman of the meeting wished the members to have the opportunity to hear Dr. Payne. The charts showing both classifications are here reproduced, that of Prof. Raymond being shown on the opposite page.

Robert M. Linton was elected chairman of the New York Section for 1922 in the balloting which took place during the evening; Prof. Robert M. Raymond and Donald M. Liddell, vice-presidents; E. L. Gruver, treasurer, and Bradley Stoughton and B. Britton Gottsberger, committeemen.

William Young Westervelt, who acted as chairman, announced that a committee on licensing of engineers had been appointed, with Donald M. Liddell as chairman. The other members were D. E. A. Charlton, B. Britton Gottsberger, P. W. Henry and Allen H. Rogers. This committee was appointed in accordance with a resolution introduced at the preceding monthly meeting of the New York Section, on which occasion licensing was discussed.



METHODS OF UNDERGROUND MINING
A Classification by F. W. Sperr

METHODS OF UNDERGROUND MINING

A Classification by R. M. Raymond

	METHOD	MODIFICATIONS	ROADWAYS AND SUPPORT	SUPPORT OF STOPE	HANDLING ORE
Supported Stope	**Bed Stoping**				
	Continuous Rooms	Breast Stoping Breast and Back Stope Heading and Bench	Pillars	Pillars Cribs Roof Caving	On Sill Floor Through Chutes to Roadway Beneath
	Underhand				
	Benches	Bench Stoping From Level Beneath Level	Level Pillars	Pillars or Arches Stulls	On Sill Floor Through Arch Chutes
	Glory Hole	Glory Hole	Arches	Open	
	Overhand				
	Open Stopes	Back Stoping Step Stoping	Level Pillars Drift Sets	Pillars Stulls	To Sill Floor Slide Chutes
	Sub-Level Stopes				
	Advance Retreat	Back Stoping Step Stoping	Level Pillars Stulls	Pillars Cribs-Stulls Stulls and Partial Filling	To Sill Floor To Sub-Levels and Inclines Through Rock Chutes to F. W. Roadways
	Shrinkage				
		Arched Longitudinally Arched long and F.W. to H.W.	Level Pillars Drift Sets Roadways in F. W.	Level Pillars and Broken Ore	Chutes in Pillars Chutes from Sub-Level
	Rill Stoping				
			Drift Sets Level Pillars	Waste Filling	Mills Blind Mills
	Cut and Fill				
	Continuous Sections Slicing	Horizontal Backs Incline Backs	Level Pillars Drift Sets Roadways in F. W.	Waste Filling Cribs on Filling	Chutes or Mills Rock Chutes to F. W. Drifts
	Square Set				
	Full Width Vein Sections	Long Step Faces Short Step or Inclined Vertical Faces	Drift Sets Square Sets Pillars	Square Set Timbers Square Set and Filling	Through Chutes in Square Sets Through Chutes and Wing or Slope Chutes
Caved Stope	**Top Slicing**				
	Continuous Stepped	Blocks with Central Mill Blocks with Manifold Mills Mitchell System	Drifts and Crosscuts Connecting all Chutes	Props and Caps or Modified Square Sets Temporary	Chutes to Main Level Mills to Sub-Levels
	Sub-Level Caving				
		Drift and Pillar Two Set Drifts Three Set Drifts	As Above	Light Drift Sets Temporary	Line of Mills to Main Level
	Block Caving				
		Single Blocks Between Levels Sub-levels and Thin Blocks	Roadways Beneath Roadways on H. W. Side		On Sill Floor Through Branched Raises To Haulage Level
	Shrinkage Stope and Pillar Caving				
		Above Main Drifts Above Sub-Levels	Drifts and Crosscuts Connecting Chutes	Broken Ore and Pillars Temporarily	Through Chutes to Main Levels Through Chutes to Sub-Levels

New Mining Law Must Be Made Acceptable to All Classes

Proposed Measure Discussed at Meeting of Mining and Metallurgical Society of America

The revised mining law now before Congress is not perfect, but its sponsors are anxious to make it so. Thus may be summed up the discussion on this topic at the monthly meeting of the New York Section of the Mining and Metallurgical Society of America at the Harvard Club, on Tuesday evening, Feb. 14. Representative S. S. Arentz, who introduced the bill into the House last July, was present as the guest of the evening; several members of the Mining and Metallurgical Society committee who formulated the new code explained their purposes, and others offered various suggestions.

F. F. Sharpless opened the program with a history of the legislation, showing that it was not a mushroom project, but had been many years in the making and was the result of wide dissatisfaction with the existing law. He stated that sentiment in the West was to the effect that the proposed revision would not benefit the prospector and was, therefore, not to be commended. To illustrate, he quoted a characteristic, bristling article published by Sidney Norman in the *Northwest Mining Truth*, asking that the Western prospector be let alone, and not worried and hounded as he had been; in short, that the existing law be allowed to stand. Mr. Sharpless reminded his hearers, however, that the prospector was not the only one to be considered; that the engineer and financier, after all, played a major part in the mining industry.

Representative Arentz then addressed the gathering. He creates the impression in manner that he is more of a mining man than a politician, and was most favorably received. He emphasized the needs of the prospector, who, after all, as he pointed out, is a pretty important member of the mining industry. Admitting the proposed bill was not perfect, he urged everyone to offer *constructive* criticism, and to point out how it could be improved rather than give it a blanket condemnation. The bill is now in committee, and hearings on it are expected to begin about the middle of March, so Mr. Arentz urged that a full discussion before that time was highly desirable. In its final form, he said, the bill should be so constructed as to meet the approval of all classes.

H. F. Bain then explained some of the features of the proposed law, and showed that most of the opposition was probably due to lack of understanding. He dwelt on the wisdom of allowing an alternative to the present requirements regarding assessment work, which are usually a waste of money and do not develop the property as would the same amount spent on road construction or devising a method of treatment. The proposed code must be so altered as to be acceptable, he said; otherwise, the existing law would later be revised by a group of lawyers along with the public land law.

Further explanatory and critical remarks were offered by Messrs. Gottsberger, Spurr, Rogers, Douglas, Ingalls, Peale, and Channing. The consensus of opinion seemed to be that the provision in the proposed law making the boundaries of claims cardinal lines was the most open to reasonable objection.

The climax of the meeting as far as interest was concerned came at the close, as it should in any well-ordered entertainment. Mr. Arentz had said that certain parts of the bill were ambiguous and cited as an illustration that section which allowed a locator to hold a property for a term of years without discovery. Was it ten years or twelve? Mr. Ingalls maintained that there was no ambiguity, and that it was only necessary to read the law to understand it. Mr. Bain then rose to say that he had read it—nay, studied it carefully—and still did not understand this point. The chairman, Mr. Weld, who had been looking over the bill the while, then sought to straighten things out by explaining just what this section actually did mean. "Am I not right, Mr. Ingalls?" "No" laconically replied Mr. Ingalls, amid much laughter from the revivified listeners. Mr. Ingalls then carefully explained this part of the bill.

Columbia Section, A.I.M.E., Views Mine Model

The February meeting of Columbia Section, A.I.M.E., was held at Spokane, Wash., on Feb. 3. Chairman Rush J. White presided. Following the routine business the chairman introduced F. W. Callaway, engineer for the Bunker Hill

and Hecla mines, who exhibited a model of and explained the underground workings of the Star mine and its relation to the adjacent properties. W. G. Woolf exhibited a series of crude ore samples and intermediate and final products of the Star mine, and explained the process of lead and zinc metallurgy by which the results were obtained.

Slate Producers Organize

Form Association to Increase Efficiency and Effect Standardization

Action was taken to form a national organization at a meeting of slate producers held at the Engineers' Club, New York, on Feb. 8, under the auspices of the National Federation of Construction Industries. About fifty delegates, representing all the slate-producing sections in Eastern states, except Virginia, were present. It was decided by unanimous vote to organize, and a committee of seven was appointed to suggest a name, prepare a constitution and by-laws, and issue a call for a meeting to complete organization.

In opening the meeting as chairman, Oliver Bowles, mineral technologist, of the U. S. Bureau of Mines, spoke of the prevalence of unscientific methods of quarrying slate and the need of substituting machinery for manual labor. Wastage, he stated, was enormous, in some quarries over 90 per cent, and no considerable development of byproducts has been undertaken. Slate production, and particularly the production of roofing slate, had rapidly decreased, and substitute materials had gained precedence, largely because no concerted effort was being made by the industry to maintain and strengthen the market for slate. A similar note of encouragement to organize was sounded by G. F. Laughlin, of the U. S. Geological Survey, who deplored the decreasing use of a material naturally so superior for many purposes.

Standardization was urged by Victor D. Abel, of the Structural Service Bureau, Philadelphia, Pa. At present sanitary slate products have to be manufactured to order, which prevents the producer from manufacturing for stock. Studies recently made, he said, showed that most sanitary and chemical slate products could be standardized to a great degree without the slightest disadvantage in use. D. Knickerbocker Boyd, architect and structural standardist, also urged standardization as a means of increasing the slate market.

Committee on Rock-Drill Steel To Meet

The directors of the U. S. Bureau of Mines and of the Bureau of Standards have called a meeting of the advisory board that is to co-operate with those bureaus in the investigation of the breakage and heat treatment of rock-drill steels and other steels and alloys subjected to similar impact stresses. The meeting is to be at 10 o'clock a.m. on Feb. 20 at the Engineering Societies Building, in New York.

MEN YOU SHOULD KNOW ABOUT

Vernon S. Rood, of the Utah Apex mine, has gone East on business.

F. C. Merritt, consulting engineer for the Loring interests, visited Reno and the Comstock early in February.

Alexander Wise, superintendent of the Comstock Middlemines Co., left Virginia City for San Francisco on Feb. 1.

John A. Burgess, consulting engineer and geologist of San Francisco, has been in Mina and Candelaria on official business.

Walter A. Rukeyser has returned from a trip to the new gold district in the Elbow Lake region of northern Manitoba.

Herbert G. Moulton has become associated with Coverdale & Colpitts, consulting engineers, 66 Broadway, New York City.

Frederic R. Weekes sailed on Feb. 11 for Venezuela, where he will be engaged on professional work for the next two months.

A. J. Young, president of the Bailey Silver Mines, Cobalt, has been elected president of the Atlas Gold Mines, in the Shining Tree district.

Allen Murray Yonge has recently accepted temporary appointment as efficiency engineer of all of the state institutions of California.

F. W. Bradley has been in Spokane recently in connection with the Day-Hecla lawsuit, but will, it is expected, return to San Francisco soon.

A. A. Richie has been appointed mine foreman of the Simon Silver Lead Mines Co., to succeed **Tom McNamara**, who is seriously ill in San Francisco.

John M. Fox resigned, the first of the year, as superintendent of the California Rand Silver Co., and is now in Johannesburg on professional business.

N. O. Lawton recently became associated with **Duncan MacVichie** in the practice of consulting and mining engineers, with an office in Salt Lake City.

G. T. Jackson, formerly manager of the Alaska Gastineau, has been appointed manager of the Shasta Zinc & Copper Co. at Winthrop, Shasta County, Cal.

H. Foster Bain addressed the Engineers Club of Philadelphia and affiliated societies on Feb. 14 on the subject, "The Field for Mining Engineers in China."

G. M. Fowler, of Salt Lake, geologist for the International Smelting Co., made a business trip through Reno, Tonopah, and southern Nevada during the first week in February.

Bradley Stoughton, formerly secretary of the American Institute of Mining and Metallurgical Engineers, was elected president of the Yale Engineering Association at the annual meeting on Feb. 2.

Donald B. Gillies, of Cleveland, vice-president of the McKinney Steel Co., the president of the Michigan College of Mines Alumni Association, recently visited Houghton and Calumet to meet the alumni.

Kenneth Williams has been appointed metallurgist at the Copper Queen smelter of the Phelps Dodge Corporation. He was formerly general foreman of reverberatory furnaces and roasters at that plant.

Oscar Spitzer, representing the International Minerals & Metals Corporation, recently visited the Wisconsin Zinc district with a view to obtaining a future calcined-blende ore supply for his company's smeltery at Springfield, Ill.

W. B. Tucker has been transferred from the Los Angeles field division of the California State Mining Bureau to the Redding branch. C. McK. Laisure, who was in charge of the Redding branch, has been made district engineer of the Bureau, with headquarters in San Francisco.

Mining and metallurgical engineers visiting New York City last week included: **E. W. Moore**, El Cajon, Cal.; **William Griffith**, Scranton, Pa.; **E. O. Daue**, Philadelphia.; **E. Mosonyi**, Bis, Mexico; **W. Spencer Hutchinson**, Boston; **A. J. Klamt**, Los Angeles; **A. L. Colby**, Bethlehem, Pa.; **W. W. Taylor**, Signal Mountain, Tenn.; **W. A. Wilson**, Salt Lake City, and **Christian Urang**, Salt Lake City.

OBITUARY

J. A. Lannon, manager of the Lucky Twenty mining company, Ouray, Col., died recently.

Arthur Ferland died at Haileyburg, Ont., on Feb. 9, at the age of sixty-six years. Mr. Ferland was one of a syndicate who purchased the property which is now the Nipissing mine and was a director of the Chambers-Ferland. company.

Eugene R. Day, managing director of the Hercules mine, and one of the most prominent mining men of the northwest, died of heart disease in Spokane on Feb. 11. Mr. Day was born in Truckee, Cal., in 1874 and went to the Coeur d'Alenes in 1886. He was one of the original owners of the Hercules mine and was also a director and stockholder in the Tamarack and Custer Consolidated Mining Co., the Northport Smelting & Refining Co., and the Pittsburgh Smelting Co.

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Leading Events

Hollinger Consolidated's suit against the Northern Canada Power Co. has been dismissed.

Four gold mines on the Rand, South Africa, where a strike has been in progress, are reported to have resumed. The outlook is considered a little brighter.

The Apache Powder Co., in which several of the large copper companies of Arizona are interested, is about to start its new plant in Cochise County, Ariz.

The Coronation Syndicate is attempting to interest the public in a new development scheme in the Transvaal. Details are given on p. 303 by our London correspondent.

Apache Powder Co.'s Plant Ready To Start

Important Mining Companies of Arizona Interested in New Enterprise

Finshing touches are being put on the plant of the Apache Powder Co, in Cochise County, Ariz, and experienced powder men are arriving daily from all parts of the country to take charge of the different departments. It is expected that the company will begin turning out powder about March 1.

The plant has a capacity of 1,000,000 lb. of powder a month, which can be increased within a short time to 1,500,000 lb. a month should the demand arise. It occupies more than 600 acres and is within seven miles of Benson and four miles from St. David.

The site of the plant is ideal as regards natural protection to the buildings and surrounding property from explosions. The plant is divided into danger and safety zones. Offices, shops, power houses, stores, and dwellings are within a zone protected from danger of explosions by high hills and ridges. This constitutes the "safety zone." The "danger zone," where the explosive ingredients are handled and powder is actually made, is in deep gullies and ravines. Each building within the danger zone is so located and protected that if an explosion should occur no damage would result to other buildings.

The different units are connected by a narrow-gage industrial track. The main plant is connected by standard-gage with both the El Paso & Southwestern and Southern Pacific railroads.

Water is furnished to the plant by a 16-in. artesian well of a capacity of several hundred gallons per minute. Employment will be furnished to about 150 skilled workmen when it is run to full capacity.

W. W. Edwards, an experienced powder manufacturer, is in charge as manager and he will be assisted by D. E. Fogg. Both will be under the general supervision of C. E. Mills, managing director.

Powder made will be that used in general mining operations, such as high explosives, dynamite, gelatine dynamite, and all kinds of permissible explosives. Raw material entering into the manufacture, based on the annual production of 12,000,000 lb. of powder, will approximate 15,000 tons. Much of this raw material is produced in Arizona.

The Apache Powder Co. is controlled by the share-holding mining companies and the enterprise is an effort to meet, in part, the economic situation confronting the mining industry. The site of the plant at Benson has been well chosen with regard to transportation facilities and the comparatively short hauls to the more important copper mines at Globe, Miami, Ajo, Bisbee, Clifton, Morenci, and Jerome, which are to be supplied with the company's product.

It is not the intention of the company to make the manufacture of powder a money making enterprise. It will sell its product at a very small margin of profit, and while the shareholders in the company will be the greatest gainers by its operation, it is expected that the mining industry of the state as a whole will be benefited.

Radioactive Ore in Congo

By Cable From Reuters to "Engineering and Mining Journal"

London, Feb. 13—Dispatches received from Brussels state that deposits of radioactive ore have been discovered in the subsoil of Katanga, in the Belgian Congo. The plateaus in that country are reported to contain radium ore, which is said to be found at shallow depth. A plant is being erected, and it is anticipated that the annual production will be of importance.

Hollinger Power Suit Dismissed

The suit of the Hollinger Consolidated Gold Mines, Ltd., against the Northern Canada Power Co. for alleged damages out of failure to supply power has been dismissed.

Receiver for El Salvador Mines

The El Salvador Silver Mines Co., with property in El Salvador, has been placed in the hands of a receiver.

New Colorado Wage Scale Gives Miners $4 Per Day

Notice Recently Filed With State Industrial Commission — Cripple Creek Expected

The new wage scale for Colorado metal mines, effective March 1, and applying in all of the principal camps excepting Cripple Creek, where the scale is 25 cents less, is as follows:

Mine Workers:	
Miners	$4.00
Machine runners	4.00
Machine helpers	4.00
Trammers	3.50
Muckers	3.50
Cagers	4.00
Timbermen	4.00
Timbermen helpers	3.50
Pumpmen	3.50
Electricians	$4.50 - 5.00
Motormen	4.00 - 4.50
Nippers	4.00
Other underground labor	3.50
Topmen	3.50
Engineers	$4.00 - 4.50
Firemen	3.50
Machinists	4.50
Blacksmiths	4.50
Blacksmith helpers	4.00
Carpenters	5.50
Shift bosses	$5.50 - 6.00
Mill Workers:	
Mill shift bosses	$4.50
Millmen	4.00
Roustabouts	3.50
Machinists	4.50
Electricians	4.50
Carpenters	4.50
Repairmen	4.75
Ore sorters	4.00
Tram men	4.00
Teamsters	3.50
Timekeepers	3.50

Indorse Proposal as to Lead Smelting

A resolution indorsing Senator Poindexter's effort to bring about a reciprocal agreement between Canada and the United States, providing that lead bullion derived from ores shipped across the international line, either way, may be returned free of duty to the country of origin, was passed at a recent joint meeting of the Northwest Mining Association and of the mining bureau of the

Spokane Chamber of Commerce. It states that such an agreement would not interfere with the lead schedules provided in the Fordney Tariff Bill and would provide alternative smelting outlets for ore from districts adjacent to the international boundary in Washington and British Columbia.

A. S. & R. Wages Still Above Pre-War Scale

An analysis of the wages paid in 1921 at the United States plants of the American Smelting & Refiining Co. shows that readjustments produced further slight decreases in the rates of pay in December compared to November rates, but that the wages paid were, in December, still 65 to 66 per cent above pre-war rates, according to a bulletin issued by the company.

The analysis states, further, that in 1914, repair, supply and construction labor was paid an average of $2.42 for an eight-hour day, whereas in November, 1920, the rate was $5.39, an increase of 123 per cent. The rate for direct operating labor in 1914 was $2.02 per eight-hour day, but in October, 1920, it had risen to $4.55, an increase of 125 per cent.

In December, 1921, through various readjustments, the rates for repair, supply and construction labor had been reduced to $4 for an eight-hour day. This was a decrease of one-half of 1 per cent compared to November rates, but 25.9 per cent below the highest rate, $5.39, paid in November, 1920.

Similarly, the rate of $3.37 in December, 1921, for direct operating labor was 1.1 per cent below the November rate, and 25.9 per cent lower than the record rate of $4.55 for this class of labor in October, 1920.

Nevada Freight Rates Lowered

Freight rates from Reno, Nev., and points on the Pacific Coast to Tonopah, Goldfield and other southern Nevada points were recently reduced from 25 to 40 per cent, effective as from Jan. 30. It is expected that this reduction will prove a stimulus to the mining industry in Nevada.

Four Rand Mines Reopen

Work was resumed on Feb. 13 in the Village Deep, the Durban Roodepoort Deep, and partially at the East Rand City Deep and the Crown Mines, according to a press dispatch recently received. Otherwise the strike situation on the Rand is unchanged.

NEWS FROM WASHINGTON

By PAUL WOOTON
Special Correspondent

Chestatee War Minerals Case May Be Reopened

Many Requests Made as to Status of Applicants Under Amended Act—Majority Seeking Rehearings

As fixed by the Secretary of the Interior, Feb. 15 was the last day on which notice of a desire to have a rehearing on claims could be filed with the War Minerals Relief Commissioner. A veritable avalanche of such requests and general inquiries as to the status of war minerals relief under the amended act has all but overwhelmed the office of Commissioner Robison. These requests have not been classified in their entirety, but it is evident that requests for rehearings and adjudications have come from the great majority of claimants, whether or not there have been awards. By broadening the "request or demand" phase of the original bill to include a published request, many claimants whose cases had been closed are now able to establish an earlier date on which they were stimulated by the Government to produce, or to prepare to produce, minerals covered by the act.

Among the cases likely to be reopened is that of the Chestatee company. Former Senator Hoke Smith, of Georgia, is pressing that claim before the War Minerals Relief Commission.

Gold Standard To Be Discussed at Genoa

Referring to the forthcoming Genoa financial conference, the Federal Reserve Board predicts that the gold standard will be an outstanding topic of consideration, and urges the gold standard as a means of rehabilitating credit and currency systems. "Discussion at Genoa is likely to relate in no small measure to the restoration of the gold standard," it says. "There is a gratifying unanimity of opinion among leading economists, financiers, and statesmen to the effect that any permanent rehabilitation of credit and currency systems will necessitate a return to a gold basis of some sort. But to reinstate the gold standard, many complex problems will have to be solved, connected with reparations payments, domestic and foreign indebtedness, and the effect of national policies upon the amount and direction of current expenditures."

Government's Silver Purchases Almost 93,000,000 Oz.

Purchases of silver by the Bureau of the Mint during the week ended Feb. 11 amounted to 1,684,000 fine ounces. This brings the total purchases under the Pittman Act to 92,958,888 fine ounces.

Indian Land Bill Reported

The House Committee on Indian Affairs has reported a bill providing for the leasing for mining purposes of certain lands on the Fort Peck, Mont., Indian Reservation.

Fibroferrite Found in Australia

Australia is said to be preparing for commercial use a newly discovered metalliferous substance known as fibroferrite. It is said to be valuable as a solvent. Its composition is: Ferrous sulphate, 50 per cent; oil of vitriol, 15 per cent; ferric sulphite, 10 per cent; alums and sulphur, 20 per cent; inert material, 5 per cent.

Appropriation Estimates Cut for Bureau and Survey

Need for Department of Mines Emphasized by Chairman Rhodes in Discussing Bill Before House

More liberal appropriations for the U. S. Bureau of Mines was urged by Representative Rhodes in the course of debate in the House on the Interior Department appropriation bill. He reviewed some of the achievements of the Bureau to indicate that it is working efficiently with the funds allowed it, but he declared that an industry which produces $6,000,000,000 of new wealth (and even that figure does not include bituminous coal) is entitled to something more than a bureau "tucked away in a secondary Cabinet office and about which little is said and less is known."

The question was raised as to what is being done with the royalties being collected under the Oil Land Leasing Act. Mr. Rhodes pointed out that these royalties do not accrue to the bureaus serving the mining industries. He called attention to the fact that 50 per cent of the royalties collected are turned into the reclamation fund; 40 per cent goes to the state and 10 per cent to the Federal Treasury. More fully to demonstrate the need for a Department of Mines, Mr. Rhodes introduced as a part of his remarks his recent article in the *Engineering and Mining Journal* on "What Can Legislation do for the Mining Industry?"

The discussion of the bill had the effect of emphasizing many of the achievements of the Bureau of Mines.

Though some reduction was made in the funds asked for the Bureau of Mines, more serious cuts were made in those for the Geological Survey. Rep-

resentative Cramton, of Michigan, who was in charge of the bill, stated that these reductions do not indicate "any lack of confidence in the Survey or any lack of appreciation of its work. They were made because we feel that some of its work can wait. The Geological Survey is a great service, and it has been administered remarkably well by Dr. George Otis Smith."

Referring at another point in his remarks to executives in the Interior Department, among whom he mentioned Dr. Smith and H. Foster Bain, the Director of the Bureau of Mines, he said "the committee was impressed highly by their zeal, intelligence, and the efficient conduct of their bureaus."

Appropriations totaling $1,580,900 for the Bureau of Mines and $1,325,940 for the Geological Survey are carried in the appropriation bill referred to. The amounts asked for the Bureau are $106,600 more than for the current year but $79,565 less than the estimates. Those for the Survey are $288,400 less than the current year and $395,120 less than the estimates. The detailed estimates are:

Bureau of Mines: Salaries and general expenses, $76,900, no change; investigating mine accidents, $378,000, a decrease of $31,065 from current funds and $36,065 from estimates; operating mine rescue cars, $211,000, an increase of $51,000 over current funds and an increase of $33,000 over estimates; purchase and equipment of mine rescue cars, $75,000, no appropriation having been made last year for this purpose, but the estimate called for $6,000 more; testing fuel, $136,000, a decrease of $6,510 from the current year; mineral mining investigations, $125,000, a decrease of $5,000 from estimates; petroleum and natural-gas investigations, $135,000, no change; mining experiment station expenses, $170,000, a decrease of $30,000 from the current year and $5,000 from estimates; care of buildings at Pittsburgh, $55,000, an increase of $5,000; mining station and mine inspection in Alaska, $35,000, an increase of $27,675 over the current year; publications, $1,000, a decrease of $500 from current funds and estimates also; enforcement of oil leasing act, $155,000, an increase of $23,000 over the current year but a decrease of $7,000 from estimates; purchase of land adjoining experiment station at Pittsburgh, $28,000, a new item.

Geological Survey: Salaries, $20,760, a decrease of $1,400 from current funds and estimates; scientific assistants, $29,900, no change; topographic surveys, $275,000, a decrease of $55,000 from the current year and also $155,000 from estimates; geologic surveys, $300,000, a decrease of $52,000 from the current year and also estimates; chemical and physical researches, $40,000, no change; illustrations, $18,280, a decrease of $6,720 from estimate; report of mineral resources, $125,000, no change; investigation of mineral resources of Alaska, $75,000, no change; gaging streams, $180,000, no change; periodicals, $2,000, no change; geologic maps, $110,000, a decrease of $30,000 from the current year and also estimates; and classification of lands, $150,000, a decrease of $150,000 from the current year and also estimates.

The committee provides for consolidating the offices of register and receiver of land offices at twenty-five district land offices and abolition of the office of Surveyor General of South Dakota.

NEWS BY MINING DISTRICTS

London Letter

Coronation Syndicate Attempting Reconstruction Scheme—Rand Strike Depresses Market

BY W. A. DOMAN

London, Jan. 31 — There must be many mining engineers in the United States who remember the great Coronation Reef fiasco, and the trouble that arose out of it among the partners of one of the leading Rand mining houses. For years the Coronation Syndicate has been dormant, but recently attempts have been made to interest the public once more. It is a new public now, and five-shilling shares are small fry when one thinks of the £3,000 which the original syndicate's shares reached. A reconstruction scheme is being brought forward, and the capitalization is to be as follows: 520,000 five-shilling shares fully paid to existing shareholders, £130,000; 1,000,000 fully paid for a property, £250,000; 400,000 to be issued for cash, £100,000; total, 1,920,000 shares, £480,000.

Authority is to be obtained to increase the capital to £750,000, so as to permit of placing 400,000 further shares under option to the old shareholders, 400,000 further shares to the underwriters, and 280,000 share in reserve. The property is reported to contain the Randfontein Reefs, which are described as "very valuable," though unproved. Two shafts are to be sunk, and it is estimated that £100,000 will be sufficient for the purpose.

A mining official has expressed the opinion that with working two reefs (Leader and West Reef) over a stoping width of 48 in. there will be 38,920,000 tons of reef on the mynpacht and discovery claims alone. This reminds me of the remarkable calculation of tonnage made years ago in connection with West Rand Consolidated. It has not materialized, and the company is not a success. The tonnage may be there—any tonnage you like on the Rand; it is the gold content that is lacking. The western wing of the great goldfield has undergone examination by many a mining engineer and geologist, Professor Molengraaf among the number.

Perhaps in connection with the above-related conditions may be quoted the Randfontein Central results for the December quarter of last year. Ore crushed was 358,000 tons, the value recovered per ton was 29s. 2d. and the working costs 27s. 8d., leaving a profit of only 1s. 6d. a ton, or £30,830 in all, and this exiguous amount has to meet certain overhead charges. Of 6,395 ft. of development sampled, 61 per cent was payable, the average value being 23.5 dwt. over 17 in. This percentage of payability was the lowest of the year, and compared with 85.1 in the final quarter of 1920.

The strike on the Rand still drags on, and it seems for the moment to have put the whole mining market out of action. Many companies are in need of additional capital; the possibility of failure, however, prevents any appeal to the public.

Johannesburg Letter

Mining Industry in Difficulties in Rhodesia—Afrikander Gold Mine May Be Reopened

BY JOHN WATSON

Johannesburg, Jan. 10—Word has been received of the closing down of the entire Rhodesian chrome-mining industry; also of nearly all the asbestos mines, and certain gold mines find difficulty in making both ends meet it is said. There is a prevalent feeling that wages will soon have to come down. The cost of living now is said to be only 23 per cent above pre-war rates. Mine managers and directors are said to have reached the conclusion that efforts must be made to reduce wages to a more moderate rate.

It is pleasing to see that there is a prospect of the Afrikander gold mine, near Klerksdorp, being worked once more. A private syndicate has been negotiating for some time for the right to mine and work this property, which is at Rietkuil. The mine has now been leased, and John Wessels, late manager of the Robinson Deep, is now manager of the company. It is said to be the intention of the management to move the ten-stamp mill already on the property to the top of the hill contiguous to the mine incline shaft and add ten additional stamps. Supplies of coal are being transported to the mine, which will soon be in operation. The mine is operated by the Afrikander Proprietary Gold Mines, Ltd.

QUEENSLAND

Interest in Mount Coolon Goldfield Revives—Gold Found at Six Mile—Mount Elliott Raises Additional Capital—The Sardine Tin Mine

(From Our Special Correspondent)

Brisbane, Jan. 9—Revived interest is being taken in the Mount Coolon goldfield, which was discovered seven or eight years ago, but which many think has not received the attention it deserves. The field lies between Clermont, 135 miles away, and Charters Towers. For some years the principal workings have been confined to one or two mines, and the owner of one is reputed to have made a good deal of money out of his holding and the small battery at which he crushes his stone. Since 1917 this mine, the Native Bear, has given good returns, reaching in one year a value of £7,300 from 1,740 tons crushed and cyanided and in 1920 returning £8,900 from 2,270 tons.

Good results obtained from another mine called the Golden Horseshoe have lately attracted renewed attention to the field, and buyers have been offering £50 each for shares in this claim, on which only £15 have been called up. There have been two crushing batteries of ten stamps each on the field, and a third has just been erected by a company that is working its mine as an open cut.

A new gold find within a few miles of the northern port of Cooktown that was briefly mentioned in these notes some months ago has been examined and reported on by a government geologist. At this place, called the Six-Mile, a gold-bearing reef was discovered by a party searching for sandal wood, an occupation followed by a good many men in the Cape York Peninsula. From this reef some good returns were obtained, one picked lot of five tons yielding over 4 oz. per ton and an average sample of three tons returning 1.6 oz. per ton. Two other prospecting areas on which some work has been carried out have not yet proved as satisfactory as on the orjginal area. In the same locality antimony has been found, but the prices ruling for this metal do not admit of its being mined profitably in any part of Queensland where it occurs.

W. H. Corbould, representing the Mount Elliott company, has succeeded in his mission to England to raise additional capital to provide for a resumption of operations by that company in the Cloncurry district. The company has a big scheme in view, which includes not only the development of its group of copper mine and the construction of eighty miles of railroad between the present end of the railway system at Dobbin and the company's rich Mount Oxide mine northwest of Cloncurry, but the erection of a central treatment plant, which is to provide, by means of a method devised by Mr. Corbould, for profitably dealing with the company's low-grade ores on a large scale. The total cost of this plan has been estimated at about £1,000,000, but an initial expenditure of at least £300,000 was stated to be necessary, the estimated cost of the proposed railway. The news now received from England is that English and French shareholders in the Mount Elliott company have agreed to the plan for raising money, and that financial groups in these two countries are to underwrite £360,000 in equal moities.

Interest is centering in the Sardine tin mine, in the Kangaroo Hills field, north of Townsville, which promises to become the "show" tin mine of Queensland and to attract world-wide attention. It is on Oakey Creek, four miles from the township of Ewan, which is eighty-four miles by road from the port of Ingham. The outcrop has been traced from the summit of a hill, from which a shaft has been sunk to a depth of 173 ft. The formation which ranges from 3 ft. to 25 ft. wide, is principally slate and quartzite. Workings have been carried on at four different levels, and the bottom level has been connected with an adit driven from the side of the hill. Excellent returns have been obtained from much of the upper ground right from the surface, and lower levels are proving better than the others. E. C. Saint-Smith, a government geologist, says definitely that the quantity of rich ore already in sight warrants the prediction that extremely profitable stoping can be carried on for the next two or three years at least. Lawrence Wilson, a mining engineer, asserts the probability of the rich ore persisting to a depth of 1,000 ft. or over, and predicts that the Sardine will become the richest and probably the most profitable tin mine in Australia.

CANADA

Ontario

Argonaut Buying Mill Machinery—Dominion Reduction May Treat Peterson Lake Tailings

Cobalt—Negotiations are under way between the Dominion Reduction Co. and the Peterson Lake company for the treatment of the tailings belonging to the last-named company. It is estimated that the tailings total about 250,000 tons, but not all of this can be recovered.

It is expected that about March 1 the Coniagas will start diamond drilling the Ruby property, on which it took an option a short time ago. Some rich ore has been recovered from the Ruby, and it is considered to be a property of much promise.

The recent find made by the Victory Silver Mines, near the Temiskaming, is showing improvement. The discovery was a blind vein which came into the shaft, and which, in places runs from 2 to 6 in. of 1,500-oz. The shaft will be continued to the 500 level.

Developments on the A-53 property are satisfactory, and it is stated that on the 60 level good milling values have been developed over a length of about 75 ft. and a width of 10 ft.

The Bailey, Coniagas and La Rose companies were the only shippers of silver ore from the Cobalt district during January, in all 110 tons being sent out.

During the week ended Jan. 27, two companies shipped ore from Cobalt. The Bailey Mines sent out one car of 64,000 lb., and the La Rose a car containing 68,000 lb.

Kirkland Lake—The Argonaut is placing orders for machinery for a mill having a capacity of from 100 to 150 tons a day. The old mill was burned about a year ago.

Good results are being obtained on the 400 level of the Bidgood.

The Ontario-Kirkland recently intersected its main vein on the 150 level, where good values were cut over a width of 6 ft.

The Crown Reserve is putting in a complete mining plant at the propery in Larder Lake which it has under option. The shaft will be sunk to a depth of 300 ft.

Porcupine—Owing to somewhat improved conditions, the Northern Canada Power Co. officials state that the company will have no difficulty in maintaining its present power supply to the Porcupine mines. The power rights recently taken over from the McIntyre will be controlled by the Northern Canada Power Co. The plant will be situated twenty-eight miles north of Porcupine, at Sturgeon Falls, on the Matagami River, and will have a capacity of between 6,000 and 7,000 hp. It is stated that orders will be placed for material immediately upon the signing of the agreement, that construction will be started by spring, and that power will be available within a year.

It is stated that Hollinger's surplus, mainly in the form of bonds and cash, now amounts to $7,500,000.

A meeting of the McIntyre shareholders has been called for Feb. 23 to ratify a proposal of the directors to increase the shares from $1 to $5 par, and giving one share of the new stock for five shares of the old.

Following the completion of diamond drilling on the Beaumont, it has been decided to sink to the 1,000 level.

British Columbia

Trail—Shipments received at the Consolidated smelter from Feb. 1 to 7 inclusive totaled 8,855 tons. Shippers were as follows: Bell, Beaverdell, 40 tons; Josie, Rossland, 74; Paradise, Lake Windermere, 30; Queen Bess, Sandon, 30; and company mines, 8,681.

P. S. Leggatt, of Thomas Summerson & Sons, Ltd., passed through British Columbia recently on his way to New Zealand, where he is interested in planning the establishment of an iron and steel industry. Mr. Leggatt is quoted as asserting that in New Zealand he purposes making immediate arrangements for the erection of a plant to handle titaniferous magnetites by the electro-thermic method.

MEXICO

Nayarit

National Railways Building Line From San Marcos to Tepic

Tepic—The situation all over Mexico is said to be increasingly good. The rebuilt section of the Southern Pacific into Tepic is in operation, and work is being actively pushed on the line between La Quemada and Tepic. The automobile road from Guadalajara to Ixtlan del Rio is completed to La Venta, and will be entirely constructed by May 1.

The National Railways have surveyed an extension from San Marcos to Tepic and are now letting the contracts for construction. The government has already appropriated $5,000,000 in gold for this work. The located line will be completed from San Marcos to Ixtlan del Rio within six months.

Coahuila

A. S. & R. Co. Opening Mines in Velardeña District

Torreon—The American Smelting & Refining Co. is resuming operations of the principal mines in the Velardeña district. A number of the old mine superintendents have been summoned to take charge of this work. Both the Terneras and El Cobre mines will resume after a long period of idleness. The railroad line running from the smelter at Asarco to the Cobre mine is being repaired and will again be used for hauling ores and supplies between Asarco and the mine.

Two copper furnaces and one on lead are being operated by the A. S. & R. Co. at the Asarco plant in the Velardeña camp. Aside from treating the ores from the company's properties, large quantities are being received from individual miners.

KOREA

Unsankinko—The Oriental Consolidated Mining Co.'s cleanup for January was $71,640. That for December was $102,000. There was insufficient water for milling purposes in January.

BURMA

Namtu—Lead production for December was 4,034 tons gross; refined lead production, 3,055 tons; refined silver production approximately 318,800 oz.

RUSSIA

Although important German interests have acquired large numbers of shares in the Russo-Asiatic Consolidated, no development of importance has yet taken place. The co-operation of the Germans was not, it is said, exactly sought; they suggested a working basis so that they might secure a part of the metals when production is resumed. The Bolshevists are beginning to recognize that without foreign capital the country cannot prosper or even be opened up. This is the beginning of a return to sanity.

ARIZONA

Inspiration and Ray Consolidated Receiving Mining Supplies—Oversupply of Unskilled Labor in Warren District

BY JAMES H. MCCLINTOCK

Bisbee—Stoping has been resumed in the Copper Queen by a force of men taken from development work, and ore shipments to Douglas are to be resumed soon. A dump of siliceous ore, taken from Sacramento Hill, is being steam-shoveled to cars for shipment to the smelter.

Calumet & Arizona is putting on more men, generally from its old force, and will start shipment of ore as soon as the Douglas bins have room. Wolverine is hiring miners, and ore shipments are to start from the Boras and Night Hawk leases as soon as the smelters are ready for ore. No intimation is given of resumption of work on the Shattuck.

At Douglas, the Copper Queen is running two blast furnaces and the C. & A. two reverberatories. The former will turn out about 5,000,000 lb. of copper during February and the latter about 3,500,000 lb.

There is annoyance already in both towns from the influx of unskilled labor, much of it from Mexico. At present only skilled miners or furnace men are getting jobs, and these only when possessing a record of prior good service with the companies. Wages remain as before the date of last spring's shutdown.

Globe—It is believed locally that Inspiration is about to resume operation of a part of its large concentrator, said to have been kept in the best of condition through the period of idleness. Among the freight recently received by the company are seventy tank carloads of fuel oil, and large quantities of mine supplies have come in. Over 1,000 men are now reported to be employed in the various sections of the mine, cleaning up and preparing for production. Both mine and crusher bins have been filled by the ore produced in the course of this work.

Old Dominion is preparing for smelter and mine operation. Upon the smelter will depend the date for resumption of production by the Arizona Commercial, which has a force of forty men repairing and cleaning up.

Ray—Ray Consolidated is said to be receiving large shipments of coal and to have its mining and milling plants in good condition.

Jerome—The furnaces of United Verde Extension at Clemenceau have been fired and have started on about three months' supply of ore in the smelter bins. Several hundred men will find employment at the smelter, in addition to 150 now in the mines. United Verde is expected to follow, by starting its Clarkdale works some time this month. The old U. V. office building above Jerome is being wrecked, to permit operation of the steam shovels, which soon will be at work again toward the surface ores around the old shaft.

NEW MEXICO

Great Eagle Fluorspar Mine Shut Down —New Last Chance Mill Ready Soon

Santa Rita—Additional men have been put on the Chino mine here and at the mill at Hurley. They are engaged in cleaning up.

Al Owens is pushing development work on his new discovery five miles east of the Grand Central mill in the Blank Range twenty miles east of Santa Rita. All assays show good values. Nine men are at work.

Whitewater—Paul Larsch and associates are shipping lead-silver ore to the El Paso smelter from their new discovery on the plains between Deming and Whitewater. The vein is 3 ft. wide and of a high grade. The operators are preparing to install a compressor and other improvements.

Silver City—Bell, Wright and associates continue to ship silver fluxing ore from their lease on the Bohemian Mining Co.'s property at Chloride Flat.

Lordsburg—The new Last Chance mill will be finished in sixty days. A 7-ft. vein of $20 rock has been cut in an exploratory drift, J. G. Nicholas is in charge. The Great Eagle fluorspar mine has been closed down pending a change in management.

Carrizozo—The Helen Ray mine, under the management of W. C. Roberson, is working its full force. Two gold bars weighing 22 lb. have just been brought in and are on exhibit at the Lincoln State Bank. They are valued at $4,500. This makes a total of 74 lb. of gold from recent runs of the mill. The mill is to be enlarged immediately. The mine is in Dry Gulch near Nogal. It is claimed that 900,000 tons of $10 is completely blocked out.

Mesilla Park—The Tortuga fluorspar mine, which is under lease from Alford Roos and associates to W. Fink and Basil Prescott, continues to ship concentrated pulverized fluorspar to eastern markets. A second unit of the concentrator is completed and running. A new grinding plant has been installed.

COLORADO

Telluride's Output Chiefly From Smuggler Union and Tomboy Mining Properties

Telluride—Shipments of ore and concentrates from Telluride for January aggregated 143 cars, as against 130 cars in December and 105 in November. Ninety per cent of the output was in the form of concentrates which were shipped by the Smuggler Union and the Tomboy mines.

Ouray—The Mountain Top Mining Co. is handling approximately 1,000 tons of ore monthly in its underground mill, which is situated at the crest of the range between Ouray and Telluride. The mill is entirely underground, employs concentration and flotation, and has been successfully operated for several years. The values are chiefly in silver and lead.

CALIFORNIA

Shasta Zinc & Copper Co. Building Refining Plant

San Francisco Correspondence

San Francisco—Northern California has been dependent for its mining activities upon gold dredging and small gold mines. The most important increase in these activities of late is due to the addition of about forty men to its force by the Shasta Zinc & Copper Co. at Winthrop for the construction of a refining plant, which is to be an accessory to the zinc and copper smelter recently built and tested. The zinc-oxide product was not completely satisfactory and a refining process was developed. It is expected that mining and smelting operations will be resumed upon the completion of the plant.

Excellent ore has been reported discovered in the South Star mine, in the Deadman's Flat district. Prospective improvements include a hoisting plant, compressors, and drills, together with mine buildings. Local reports announce the completion of payments upon the Normandie-Dulmaine group and the continuance of shaft shinking, which has reached the 100 level. The Roman Group Co., with a property at Sierra City, is preparing to resume work upon its mine near the Sierra Butte mine. The Brush Creek mine, at Mountain House, below Allegheny, is to be reopened during the spring. Near Greenville, in northern Plumas County, machinery has been erected and buildings have been repaired preparatory to development of the Arcadia and Southern Eureka groups by the Madre Mines Co. Diamond drilling is to be started at once upon the Gruss mine, in Plumas County, by the Diamond Drilling Company.

Recent storms have interfered with the operation of the Plymouth Consolidated, at Plymouth, and power was cut off for a short time. T. E. Kelso and W. H. Holmes are sinking a new shaft at the Princeton mine, one of the old properties of the Mariposa Grant, nine miles southeast of Bagby.

The Pattison mine, near Tuttletown, after operating its new mill one month, has shut down. Local reports indicate over-optimism in the judgment of ore reserves.

The Grady lease, in the Randsburg mining district, has just started shipping. It has produced in the last year $1,000,000 worth of silver from ground 125 ft. square by 440 ft. deep.

Two more mines were opened last summer, the Coyote and the Bisby. The Coyote is about 1,500 ft. southeast of the Kelly property and the Bisby 2,500 ft.

The Johannesburg Mining & Milling Co. owns the Silver Moon and Silver King properties. The Silver Moon joins the Kelly on the southwest and starts about 500 ft. from the Kelly mine. This property is being developed by a 5 x 7-ft. shaft and is now near the 300 level and is in the same formation as the Kelly.

MONTANA

Anaconda To Run at Capacity When Skilled Labor Supply Permits—Tuolumne Cuts New Copper Vein

By A. B. KEITH

Butte—The Anaconda Copper Mining Co. plans to resume at capacity as soon as the experienced labor can be had. A number of the properties are in need of some minor overhauling, such as the replacement of rails on different levels, repairing of chutes, and cleaning up of workings, but this work will not require much time. To build up forces, however, with the right kind of labor will prove more difficult, judging by the results obtained thus far. Green men who have been worked in between older hands are expected to show improvement in time, and this will make practicable the sending of new hands underground and gradually breaking in an efficient force.

The company now has four of its larger mines well under operation, with production about ready to start at three more, and probably four or six more properties will be ready for resumption soon. Anaconda now has on its Butte payrolls more than 5,000 men, the forces at the other companies bringing the total up to about 7,000. The Butte & Superior now has employed about 700 men and is gradually increasing its shifts, with the 1,000 set as the mark. The Davis Daly company is planning to resume within two weeks, and this will put about 300 or 400 more to work.

Butte & Superior has opened from 17 to 19 ft. of ore on the 2,600 level of the Black Rock mine, with the grade of shipments to the smelter holding at 5 per cent copper and from 5 to 7 oz. of silver. Drifting has started on the copper vein at this depth, with the body promising a continuity of values of the same general character as are being had on the 2,200, although the greater width of ore is being shown on the deeper level, the deposit on the 2,200 level ranging in width from 11 to 15 ft. The Black Rock mill is operating at about 80 per cent of capacity, and it is believed that capacity will be attained within sixty to ninety days.

The Tuolumne Copper Mining Co., in sinking the Main Range shaft below the 1,700 level, has cut a new vein, one of the so-called northwest series, showing a width of about 4 ft., with well-defined streaks of gray copper. The vein appears to be improving with depth. It is standing perpendicularly, and in all likelihood will have the shaft in it for some time. The ore is not yet commercial, but is regarded as a good indication of increasing mineralization with depth. These "northwesters" show nothing at the surface, but experience has proved in the Butte district that with depth they often have developed orebodies of much importance and value. Sinking is progressing, with the 2,400 level the objective.

Drifting westerly on the 1,600 level of the Spread Delight has been halted temporarily, pending the cutting of more water tanks on this level to care for the flow of water met in the shaft. Chutes on the 1,000 level are being repaired preparatory to resuming production when the Anaconda smelters are ready to purchase custom ore.

East Butte has opened 1 ft. of ore on the 800 level, assaying more than 3 per cent copper and about 7 oz. of silver in a vein believed to be the westerly extension of the Spread Delight fissure of the Tuolumne.

Boston & Montana Development is shipping concentrates containing about 30 oz. of silver, over 3 per cent copper, and from $.60 to $2.80 in gold. In addition, lead concentrates are being shipped, running up to 45 per cent lead and 65 oz. of silver. The daily mill tonnage is 250, with an increase to more than 300 scheduled soon. The concentration ratio is five to one, with the recovery up to 93 per cent. Shipments of concentrates are being made to the Tacoma smelter of the American Smelting & Refining Co. Lower smelting schedules have been offered by the Anaconda and the East Helena smelters, it is said.

NEVADA

Operations at Tonopah Normal—Weather Stops Leasers at Royston

(From Our Special Correspondent)

Tonopah—Recent bullion shipments from the Tonopah district are reported as follows: Tonopah Belmont, $118,000; Tonopah Extension, $62,500; Tonopah Mining, $50,000; and West End, $62,000. This represents the clean up for the last half of January at these properties.

The Jim Butler mine is being operated by leasers, and several men are working on the West End, Fraction, and other veins with varying success.

No company work is being done. The West End continues to ship ore from a certain section which has been operated under lease by that company for several years. Favorable developments continue from the 900 level of the Halifax mine. The raise on the Halifax vein shows good ore, with but one wall in sight, and another raise being driven in the hanging wall of the main vein, following a 6-in. stringer of high grade, is producing good ore. Regular shipments are being made to the West End mill.

Royston—Practically all work by leasers has temporarily ceased on account of adverse weather conditions. The second shipment from the Betts lease of fifty-two tons, ran $311 per ton and had a gross value of $16,235. The ore contained 297 oz. silver, $8.60 in gold, and 20 per cent lead.

Spanish Belt—There is about 5 ft. of snow at the Spanish Belt mine, and operations have been so hampered that it has been deemed advisable to stop all work until weather conditions improve. About twenty men have been employed. Underground conditions are said to be excellent, and the mill has been running well.

UTAH

Columbus-Rexall Estimates Extent of New Ore Recently Found

From Our Special Correspondent

Alta—Snowslides in Little Cottonwood Canyon, although damaging the Michigan-Utah tramway and carrying away a corner of the South Hecla boarding house, have not been serious this season. It is intended to replace the Michigan-Utah tram with a new installation, as the old line is considered worn out, and in the meantime shipment will be made by teams. The capacity of the tram is thirty-five tons in twelve hours, and, with sufficient teams available, it is planned to increase the output.

The management of the Columbus-Rexall estimates that enough work has been done on the new ore to place its extent at 5 or 6 ft. in thickness, persisting throughout an equilateral triangle with a base of 160 ft. How much further the ore extends must be determined by development.

Eureka—The Empire mine of the Empire Mines Co., a consolidation of a number of properties under Knight control, is being sampled, and preparations are being made to reopen the Carisa and Spy sections of the property. Shipments from the Grand Central for the week ended Feb. 4 amounted to eight cars, and a larger output is expected the week following. A considerable amount of ore has been kept back in the mine, owing to the necessity of making repairs on the tramway. The power line extended from the Chief Consolidated is almost completed, and the work of installing a new compressor is well under way.

JOPLIN-MIAMI DISTRICT

Indian Land Regulations Causing Weakness in Ore Prices?—Webber Mine Producing Heavily

BY P. R. COLDREN

Joplin—There is a feeling in this section on the part of the officials of some of the larger companies that the recent regulations of the Indian Department concerning the leasing of mining lands may be having something to do with the weaker tendencies in ore prices. It is the belief of these officials that under the new regulations the Indian agent may and probably will require active mining operations to be started on a good many tracts that now are inactive. One of the largest companies in the field, for example, believes that it may be required to build concentrators on six leases that it owns, but which it has been holding in reserve. Such action would naturally increase the output of zinc ore, and the theory is that the smelters foresee this increased output and believe that the ore surplus will become greater in the months to come and will exercise a bearish influence on prices.

Output from the Commerce Mining & Royalty Co.'s Webber mine, in Kansas just north of Picher, Okla., has been heavy recently. For the week ended Feb. 7 a total of about 650 tons of concentrates was made, about one-half of it being lead ore. The same company's West Side mine, just east of the Webber, which was only recently opened, is also proving an excellent property.

The new West Side mine of the Commerce M. & R. Co. started operating Jan. 11, running rich lead ore through its new mill. It is just to the north and east of the Vinegar Hill Barr mine, in Kansas, and mining operations will be carried on under a portion of the Blue Mound.

Frank Childress, of Galena, and Chicago associates have taken over the Whitebird mine, at Picher, Okla. This is a different organization from that which took over the Muncie, Blue Ribbon, and Homestake mines about a month ago. L. Lehmie, of Chicago, represents the interests in that city in the negotiations for the Whitebird. The mine is not to be confused with the Eagle-Picher Lead Co.'s mine of the same name. It is about a mile to the east of the Picher property, and has been a steady producer for the last two years, up to several months ago, when it was shut down on account of low ore prices.

MINNESOTA

Consumption of Mesabi Ore Increases Slightly

Hibbing — According to available figures, the consumption of ore by furnaces supplied by the Mesabi Range shows a slight improvement. The tonnage consumed during December was 2,577,000, which compares favorably with 2,188,000 tons consumed in November, 1921. There was available 35,895,000 tons on hand on Jan. 1, 1922, with 8,434,500 tons at the docks and 27,461 tons at the furnace yards. The stated tonnage, in comparison with 38,047,000 tons on hand on Jan. 1, 1921, shows a small decrease.

Coleraine—The stripping work being done by Butler Bros. at the South Judd, a property of the Oliver Iron Mining Co., is rapidly nearing completion. The total amount of overburden to be removed was approximately 2,500,000 yd. It is anticipated that some ore operations will be carried on by the Oliver this shipping season.

Keewatin—The Bennett mine, operated by Pickands, Mather & Co., has resumed operations after long idleness. A day shift is being worked employing about 130 men.

Chisholm—The Oliver Iron Mining Co. has announced that stripping will be resumed at the Frazer open pit at once. This property has been closed about four months. It is planned to work one shovel and about 150 men.

Vermillion Range

Armstrong Bay Mine Now Producing

Tower—The Armstrong Bay mine, of the Chippewa Iron Mining Co., has entered the production stage and is now producing from sixty to seventy tons per day. This ore is being stockpiled and will be shipped the coming season. The spur leading to the mine will be completed early this spring.

MICHIGAN

The Copper Country

District's Output of Copper on April 1 To Be About 5,000,000 Lb. Per Month

BY M. W. YOUNGS

Houghton—When Calumet & Hecla and three of its subsidiaries, Ahmeek, Allouez, and Isle Royale, have resumed about April 1, the actual increase in refined copper production from the Lake district will be only about 3,000,000 lb. per month. The output will be at the rate of about 5,000,000 lb. per month. The present metal output is between 8,000,000 and 9,000,000 lb. per month.

Since the shutdown of the mines last spring, Calumet & Hecla has continued to operate its smelter, smelting such mineral and mass copper and cupola blocks as had accumulated, and an average of more than 2,000,000 lb. a month of refined copper has been turned out. The smelter now has only enough material to keep it operating until a new supply comes from the mills upon the resumption of mining.

Calumet & Hecla will mine only its conglomerate lode when production is started. The conglomerate department produced 34,000,000 lb. of copper in 1920, but it will not approach that rate when mining is resumed. There has been considerable caving and crushing of the lode in the shafts, and not all of them will be in readiness April 1 for normal operations. Production for some months may not be greater than 2,000,000 lb., refined, monthly.

Ahmeek produced 20,000,000 lb. of metal in 1920. This property, it is expected, will nearly approach that rate of output soon after resumption of operations. Isle Royale produced 10,000,000 lb. in 1920 and Allouez at the rate of 5,000,000 lb.

Mohawk and Wolverine are producing at capacity. It is not expected that Copper Range and Quincy will increase their outputs for some months.

Both Champion and Trimountain, of the Copper Range company, showed a small increase in rock production in January, and Baltic maintained the rate which obtained in December. Champion is now sending 2,500 tons of rock daily to the mill, increasing its total from 62,000 to 65,000 tons for January, and Trimountain increased from 13,000 to 14,000 for the month. Baltic sent 16,000 tons to the mill. All drifts and stopes continue to yield ground fully up to the average for these mines. A normal amount of opening work is now in progress in Champion and Trimountain, but Baltic is still under normal. Champion made a net gain of about thirty men in January, the other mines holding their own in the labor turnover that is customary.

Mayflower has stopped work in the north drift, the heading of which is in about 200 ft. on the 1,450 level, and a south drift has been started.

Gogebic Range

County Inspector of Mines Makes Annual Report

Ironwood—The annual report of the Gogebic County Inspector of Mines for the year ended Sept. 30, 1921, has been published, and from it the following statistics are taken: Tonnage of ore mined 4,462,089; average total number of men employed at the mines, 4,796; average underground, 3,045; on surface, 1,751; open pits, 257. The number of fatal accidents was eleven, but this includes one which was in no way due to the hazards of mining. Serious accidents where the disability extended over six months numbered thirty-three. Accidents where disability was from one week to six months numbered 506. Seventeen mines were operated by eight companies during the year.

The Oliver Iron Mining Co. employed 2,217 men and mine 1,911,356 tons. The Steel & Tube Co. employed 929 and mined 695,532 tons. The McKinney Steel Co. employed 353 and mined 303,776 tons. The Oglebay, Norton Co. employed 389 and mined 225,788 tons. The Charcoal Iron Co. employed 141 and mined 153,853 tons. The Hayes Mining Co. employed 154 and mined 84,734 tons. The Republic Iron & Steel Co. employed 106 and mined 64,575 tons. Pickands, Mather & Co. employed 184 men at its underground mine and mined 136,630 tons; and 173 men at its open pit mined 708,669 tons. The M. A. Hanna Co. at its open pit employed eighty-four men and mined 183,176 tons.

Menominee Range

Chapin and Aragon Mines To Resume—Cleveland-Cliffs To Do Diamond Drilling at Iron River

BY WILLIAM H. NEWETT

Iron Mountain—Orders have been received to resume work at the Chapin mine, at Iron Mountain, and at the Aragon mine, at Norway. Men are now being taken on as places can be made for them. The first work to be done is to provide trestles for stockpiling. All married men formerly employed are to be engaged, which will give a force of 525 at the Chapin and about 290 at the Aragon. The mines have been closed for the last eight months. No scale of wages has been announced.

Iron River—Diamond-drill operations will be conducted by the Cleveland-Cliffs Iron Co. on the property next adjoining the Spies, in the Iron River district.

The Bristol Mining Co. has increased its working force to sixty-two men, these being employed on a full-time schedule. The company had been operating on half time throughout the winter. The McKinney Steel Co. wage scale has been adopted, this being somewhat lower than was paid on the half-time plan. All work will be done on the 1,400 level, the lowest that was reached in the shaft last summer and which was not opened at that time. A drift through the rock from the bottom of the shaft has been started to reach the orebody.

At the Odgers mine, development work is in progress. The pocket and crusher at the bottom of the new shaft are completed. The work of installing the tramming system will soon be under way. With the new shaft ready, the lower part of the mine will be opened and developed and considerable mining will also be done in the upper levels where ore is still to be extracted.

At the Carpenter and Monongahela mines, operations are proceeding quietly. At the latter it is reported that explorations made in the northwestern portion of the property are resulting favorably. The company continues to operate its diamond drills near Alpha, but reports that no ore has been found.

The Judson is the only mine operating at Alpha, where 125 men are engaged. These have been given work to aid the district during the period of depression.

Marquette Range

Draining of North Lake Completed by Cleveland-Cliffs Company

Ishpeming—The Cleveland-Cliffs company has finished draining North Lake, in the Ishpeming district, it having been lowered until now there is only a small pool in the deepest portion of the basin. This will probably not be removed until the ice melts. There are many fine trout in this pool, and it is the plan to save them and to use them in stocking the streams of this section. The removal of the water is to guard against its encroachment on the underground workings of the company's Barnes-Hecker mine, nearby.

No orders for resumption of work at any of the mines of this range have as yet been received and no sales of ore have been reported.

NEW YORK

Mining Operations in State Much Curtailed During Last Year

Iron mining in the Port Henry district in 1921 proceeded at the rate of approximately 40 per cent of that in 1920. The New Bed mine and the No. 4 mill, the low-phosphorus operations of Witherbee, Sherman & Co., suspended operations entirely April 1, and have been idle since. The curtailment of production resulted in a good deal of idle labor in the district throughout the year. Wages were reduced twice during the year and are now on the 1916-17 scale. Diamond drilling and other exploration have been suspended in the district since early last spring. There have been no new developments or plant additions. The companies are endeavoring to carry on with even low production until general business conditions improve. Small shipments of ore during 1921 resulted in the largest accumulation of ore in stockpile the district has ever known.

The Ramapo Ore Corporation, at Sterlington, has been idle all year. The Fort Mongomery Iron Corporation operated the Forest o' Dean mine continuously throughout 1921.

The only hematite mine operated in 1921 was the Clinton hematite mine, at Clinton, Oneida County. The mine was worked on a limited scale for the paint industry only.

The New York Pyrites Co., at Gouverneur, has been running its mine and mill, producing rich ore for fertilizer and paper trades.

The mines of the American Graphite Co., on Lake George, and those of Hooper Bros., at Whitehall have been idle. Foreign competition and the high price of coal in these remote localities are given as reasons. Resumption of operations is not looked for until electric power is obtainable.

Exploration work only was done during 1921 at the zinc mines of the Northern Ore Co., at Edwards, and at the plant of the Hyatt Ore Corporation, at Taleville.

The talc plants that worked continuously in 1921 were those of the International Pulp Co., and the W. H. Loomis Talc Corporation, both of Gouverneur. The former added to its milling capacity by remodeling one of its mills, and the latter, which entered the market in 1921, is installing additional machinery for larger production and finer grinding.

The two producers of rock salt, the Retsof Mining Co., at Retsof, and the Sterling Salt Co., of Cuylerville, produced their average tonnage in 1921. The Restof company is sinking a new shaft within a mile or so of the present operating shaft. This elliptical, concrete-lined shaft will be, when completed, 1,100 ft. deep. It will have two ore compartments and one cage compartment. The Dravo Contracting Co. of Pittsburgh is doing this work, and has already reached a depth of 550 ft.

The Cayuga Rock Salt Corporation, of Portland Point, late in the year started exploration of the salt beds in its shaft near Ithaca.

The production of garnet has been steady at North River, at the mines of the North River Co. and H. H. Barton Sons Co. The American Glue Co. also mined and milled a small quantity in the same vicinity.

The mine and mill of Kinkle Bros., at Bedford, have been producing feldspar on a limited scale. The Green Hill Mining Co., of Gouverneur, also has been shipping feldspar from its mine at Old De Kalb, in St. Lawrence County.

All the gypsum mines worked steadily during 1921 and reached their average tonnage. The increase in the variety of uses and the improvements in the manufacture of wall boards and various other products called for a steady production.

THE MARKET REPORT

Daily Prices of Metals

Feb.	Copper, N. Y., net refinery* Electrolytic	Tin 99 Per Cent	Tin Straits	Lead N. Y.	Lead St. L.	Zinc St. L.
9	13.00	30.50	31.25	4.70	4.375@4.425	4.50
10	12.75@13.00	30.00	30.875	4.70	4.375@4.425	4.50
11	12.75@13.00	30.00	30.875	4.70	4.375@4.425	4.50
13	.....	.....	.....	4.70	.....	.....
14	12.875@13.00	30.00	31.00	4.70	4.375@4.425	4.475@4.50
15	12.875@13.00	29.375	30.375	4.70	4.375@4.425	4.475@4.50

*These prices correspond to the following quotations for copper delivered: Feb. 9, 13.25c.; Feb. 10, 11, 13@13.25c.; Feb. 14, 15, 13.125@13.25c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York, cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Tin is quoted on the basis of spot American tin, 99 per cent grade, and spot Straits tin.

London

Feb.	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic	Tin Spot	Tin 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
9	61⅜	62¼	67	154¼	156	21	20⅞	24⅛	24⅝
10	61½	62½	67	152¼	154¾	20¾	20⅝	24	24¾
11	...	...	...	.....	.....	...	...	...	...
13	61⅝	62⅜	67	153⅛	155⅛	21	20⅞	24¼	25
14	61	61⅞	67	152	153¾	20¾	20⅝	23⅞	24⅜
15	60⅛	61⅛	66	149¼	151	20½	20⅜	24	24½

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver New York Domestic Origin	Silver New York Foreign Origin	Silver London	Feb.	Sterling Exchange "Checks"	Silver New York Domestic Origin	Silver New York Foreign Origin	Silver London
9	437	99⅝	65⅞	34½	13	....	...	...	34½
10	434¾	99⅝	65¾	34⅜	14	435½	99⅝	66⅜	34⅜
11	432	99⅜	65⅞	34⅜	15	435	99⅝	66⅜	34⅜

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Metal Markets

New York, Feb. 15, 1922

Conditions in the local metal market are virtually unchanged, though there is a feeling about that copper may show a stronger tendency any day and there was less tendency yesterday and today to cut prices. Tin is somewhat weaker, particularly in London, but lead and zinc are holding up well at current quotations.

Copper

The copper market has been decidedly uncertain during the last week. For several weeks the price declined steadily, and on last Thursday an extreme low of 13c. delivered was reached for a large lot. This seems to have cleaned up the market for metal at that level, however, and yesterday and today it was impossible, so far as we are aware, to obtain copper for less than 13.125c. delivered. Most producers were quoting 13.25@13.50c. all the week, and a fair tonnage was sold at the lower figure. In general this business was placed by the larger producers, the custom smelters and outside interests being obliged to shade these prices somewhat in the effort to make sales. Inquiries and orders have not been of large proportions, but have shown a gain over last week, and it would not be surprising to see sales improve again from now on. A novel explanation of the decline was published in today's papers, to the effect that a loan had been called, for which eight or ten million pounds of copper had been held as security. The sudden marketing of this was supposed to have weakened the market. This sounds exceedingly piscatorial. The smaller interests would hardly be likely to have as much copper as this on their hands, and the larger companies have been in no such urgent need of money after the successful business of the last quarter as to compel such a sudden liquidation. Furthermore, copper is now excellent security.

Export business has improved, sales to Germany and France being more satisfactory than for some weeks. Oriental inquiries have also been more encouraging. Prices have without doubt had some influence, for it is understood that the Copper Export Association is actively competing for business and has taken some of it from the English metal dealers.

Lead

Lead has continued to pursued the even tenor of its way during the last week. The official contract price of the American Smelting & Refining Co. continues at 4.70c., the level of recent months. Sales of normal volume have been made at this price by the Smelting company and others, though favored brands command a 5-point premium. There is little choice between desilverized and chemical lead; the premium on the former, which existed for a time, seems to be gradually disappearing. In the Middle West most of the sales have been made at 4.40c., though it is reported that lead can still be obtained from one or two producers at 4.375c. At the other end of the scale some companies have netted 4.425c. on practically all of their sales made on a St. Louis basis. The Chicago price for common lead has been 4.50@4.525c. There is no interest in forward metal. The London market continues soft.

Zinc

The zinc market has been exceptionally quiet, remaining for the entire week at practically 4.50c., some sales at slight concessions being made yesterday. Industrial conditions are still unsatisfactory as regards the galvanizing trade, inquiries from those quarters showing no improvement. Several of the larger producers are still out of the market. Monthly statistics issued by the American Zinc Institute show a diminution of stocks during January. Stock on hand Jan. 1 was 66,608 tons; production in January, 23,706; shipments, 24,636; and stock on hand Jan. 31, 5,678. Average number of retorts operating during the month, 43,873.

High-grade zinc was sold in good volume at unchanged price, 6c. per lb., with freight allowed.

Tin

Tin has been weak in London, today's quotation being within £1 of the lowest price in years. Improved sterling exchange recently has prevented the New York price from approaching the low levels of last year, however. Continued outpouring of hidden stocks held in the Far East has no doubt had a depressing effect on the market. Possibly the price is being depressed to cause a curtailment of production. Local sales continue in fair volume. The tin-plate business is flourishing and is perhaps the brightest spot in the steel business at the present time.

Tin for May delivery was quoted as follows: Feb. 9th, 30.875@31c.; 10th, 30.50@30.75c.; 11th, 30.50@30.75c.; 14th, 30.50@30.75c.; 15th, 30@30.125c.

Arrivals of tin, in long tons: Feb. 8th, Liverpool, 75; Rotterdam, 100; 9th, London, 250; Straits, 5; 10th, Straits, 500; 11th, London, 485; 14th, London, 50.

Gold

Gold in London: Feb. 9th, 95s. 1d.; 10th, 95s. 1d.; 13th, 95s. 6d.; 14th, 95s. 4d.; 15th, 95s. 4d.

Foreign Exchange

Sterling has fluctuated through somewhat wide limits, and some expect a reaction before higher levels are reached. European exchanges generally have shown firmer tendencies. On Tuesday, Feb. 14, francs were 8.635c.; lire, 4.86c.; and marks, 0.505c. New York funds in Montreal, 5 per cent premium.

Silver

The market has been dull and narrow, with sales by China and the Indian bazaars buying intermittently. So long as this condition continues, and the trend of sterling exchange rates remains obscure, it is impossible to predict the future of silver.

Mexican Dollars—Feb. 9th, 50⅛; 10th, 50⅛; 11th, 50⅛; 14th, 50⅛; 15th, 50⅛.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—20c. per lb. for 99 per cent grade; 19c. for 98@99 per cent; 18c. for 94@98 per cent. Outside market nominal at 17@18c. for 98@99 per cent virgin grades.

Antimony — Chinese and Japanese brands, 4.45c.; market dull. **W.C.C. brand, 5⅛@5⅜c. per lb. Cookson's "C" grade, spot, 9c. Chinese needle antimony, lump, nominal at 4c. per lb. Standard powdered needle antimony (200 mesh), nominal at 5.25c. per lb.**

White antimony oxide, Chinese, guaranteed 99 per cent Sb_2O_3, wholesale lots, 6½@7c.

Arsenic—7½c. per lb. Strong.

Bismuth—$2@$2.10 per lb.

Cadmium—$1@$1.10 per lb., in 1,000-lb. lots. Smaller quantities, $1.10@$1.25 per lb.

Iridium—Nominal, $170@$190 per oz.

Nickel—Standard market, ingot and shot, 41c.; electrolytic, 44c. Small tonnages, spot, nominal at 32c.

Palladium—Nominal, $55@$60.

Platinum—$85@$90 per oz.

Quicksilver—$48 per 75-lb. flask. San Francisco wires $47.30. Firm.

The prices of **Cobalt, Molybdenum, Monel Metal, Osmium, Rhodium, Selenium, Thallium and Tungsten** are unchanged from the prices in the issue of Feb. 4.

Metallic Ores

Bauxite — American, crushed and dried, $6@$8 per gross ton; pulverized and dried, $12@$14 per gross ton; calcined, $20@$22 per gross ton, all f.o.b. shipping points. Foreign bauxite offered at $6@$8 per metric ton, c.i.f. Atlantic ports, depending upon grade.

The prices of **Chrome, Manganese, Tungsten, Molybdenum, Tantalum, Uranium, Vanadium,** and **Iron Ore, Zircon** and **Zirkite** are unchanged from the prices in the issue of Feb. 4.

Zinc and Lead Ore Markets

Joplin, Mo., Feb. 11—Zinc blende, per ton, high, $29.85; basis 60 per cent zinc, premium, $26@$27; Prime Western, $25@$23; fines and slimes, $23@$20. Average settling price, all grades of blende, $26.39.

Lead, high, $64.35; basis 80 per cent lead, $60. Average settling price, all lead ores, $62.41 per ton.

Shipments for the week: Blende, 7,776; lead, 2,407 tons. Value, all ores the week, $355,520.

Shipment and production are paralleling each other so closely that zinc stocks are increasing only slightly at the mines. Sellers are holding against further reductions in price offerings, and as a result one buyer found it necessary to advance offerings $1 on one lot of premium-grade ore. One other lot sold on $26 basis, with the bulk of Prime Western bringing $25, though it is claimed a few purchases were made on $24 and $23 basis. Lead production is larger, and it is through the association of the minerals that zinc production is increased. Mines operated for lead are paying expenses from its production and holding the zinc for a stronger market.

Platteville, Wis., Feb. 11.—Blende, no sales. Lead ore, basis 80 per cent lead, $60 per ton. Shipments for the week: Blende, 152; lead ore, 147 tons. Shipments for the year: Blende, 1,703; lead ore, 457 tons. Shipped during the week to separating plants, 217 tons blende.

Non-Metallic Minerals

There are no price changes from those indicated in the market report of the issue of Feb. 4 covering **Asbestos, Barytes, Borax, Chalk, China Clay, Emery, Feldspar, Fluorspar, Fuller's Earth, Graphite, Gypsum, Limestone, Magnesite, Mica, Monazite, Phosphate, Pumice, Pyrites, Silica, Sulphur** and **Talc.**

Mineral Products

The prices of **Copper Sulphate, Potassium Sulphate, Sodium Nitrate,** and **Sodium Sulphate** are unchanged from the issue of Feb. 4.

Ferro-Alloys

Ferromanganese—Domestic, 78 to 82 per cent, $59@$60, f.o.b. furnace; English and German, $62.50, c.i.f. Atlantic seaport. Spiegeleisen, 18@20 per cent, $25@$27 per gross ton, f.o.b. furnace.

Ferrovanadium—$4 per lb. of V contained, according to analyses and quantity.

The prices of **Ferrotitanium, Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrosilicon, Ferrotungsten** and **Ferro-uranium** are unchanged from the issue of Feb. 4.

Metal Products

Copper Sheets—Current New York list price, 21.25c. per lb.; wire, 14.50@14.75c. This price should also have been quoted last week.

The prices of **Lead Sheets, Nickel Silver, Yellow Metal** and **Zinc Sheets** are unchanged from the issue of Feb. 4.

Refractories

The prices of **Bauxite Brick, Chrome Brick, Chrome Cement, Firebrick, Magnesite Brick,** and **Silica Brick** are unchanged from the issue of Feb. 4.

The Iron Trade

Pittsburgh, Feb. 14, 1922

The report of steel-ingot production in January shows that demand for steel was increasing more rapidly than the mills were reporting during the month. Competition for orders, even for small ones, became keener at the beginning of the month.

The average rate of ingot production in January was about 22,750,000 tons a year. Production during December had been decreasing, with an average rate of about 19,750,000 tons during the month, so that January presumably started with a rate under 18,000,000 tons and ended with a rate above 23,000,000 tons, and the rate may now be up to about 25,000,000 tons. Practically all buying is from hand to mouth, for prompt shipment.

Regular prices for the leading steel products are unchanged, but in most lines, sheets being an exception, concessions have become common, even on relatively small orders. Most mills have not been earning their overhead, but they are doing somewhat better as operations increase.

Pig Iron—The market remains quotable at $19.50 for bessemer, $18 for basic, and $19 for foundry, f.o.b. Valley furnaces, but on a large lot probably any one of these prices would be shaded.

Coke

Connellsville — Furnace, $2.85@$3; foundry, $3.75@$4.25.

The Copper Market Has a Reaction

EDITORIAL MARKET STUDY

COPPER has taken a slump. The rise that began last August, when copper sold for 11⅞c. delivered, and which carried the metal close to 14c., has been partly dissipated by the decrease of the last few weeks. It is the first heavy decline for almost six months. Several copper companies, no doubt impressed by the gradual advance in copper until a short time ago, recently announced a resumption of operations. Anaconda was the first to take this step. The companies that have resumed or contemplate soon doing so are now

Anaconda Copper Mining Co.
Calumet & Hecla Mining Co.
Ahmeek Mining Co.
Allouez Mining Co.
Isle Royale Mining Co.
Old Dominion Copper Mining Co.
Copper Queen Mining Co.
United Verde Extension Mining Co.
Calumet & Arizona Mining Co.

Although these producers will operate at greatly reduced capacity, they will furnish an appreciable addition to current supplies, which should make itself felt after May. With copper between thirteen and fourteen cents per pound, the price was doubtless attractive enough to warrant production (the average price in 1909-1913 period, inclusive, was 13.94c.) as it is conceivable that the loss sustained by selling copper in a market at that level might be less than that entailed by a total shutdown. The eagerness of other producers to resume will probably be tempered by the recent drop in the market.

It is noticeable that the porphyry coppers are still closed down, and seem determined to remain so until industrial conditions have shown greater improvement. It would be calamitous at this time to plan for a wholesale resumption by the large companies. Producers such as Utah, Ray, Chino, Nevada, and other companies deserve great credit for their decision not to produce copper at present and for their attitude toward the market. In general those companies which have a common selling agency and operate their own properties have acted as a stabilizing influence in the copper market, refusing to sell when the market dropped to abnormally low levels and in refraining to press the metal upon an unwillingly receptive market. Owing to their financial strength, these companies were able successfully to carry out the policies noted. One would hesitate to conjecture how low the price of copper would have sunk had the larger producers been free sellers in the market.

HEAVY SALES MADE FOR FUTURE DELIVERY

On the other hand, those copper companies which do a custom business actively compete for all business available. It is maintained that this attitude is warranted by the constant intake, which is bought at specified prices. If a compensating outgo of metal is not provided for, a tendency toward speculation would be introduced. Bitter experience in the past has shown the folly of holding metal from the market. Thus two selling principles have been evolved in the copper trade.

Although the decline in price can be attributed to the prospect of increased supplies of copper, other factors in the market may be considered equally important. Thus, domestic buying evidently overdid itself in the last scramble for copper. One of the features of that buying movement which probably was not greatly emphasized at the time was the great preponderance of purchases for future delivery. Sales for delivery, one, two, three, or more months ahead were the rule, not the exception. In fact respectably sized quantities were sold for delivery as far ahead as next winter. Normally, copper producers are not interested in the market so far ahead. Some of them distinctly discourage forward buying by quarters.

As a result of the heavy sales of copper early this winter, for forward delivery, the market has behaved as one consumer felt it would, the demand at that time absorbing metal that would have been taken later. Consumers who purchased copper a few weeks ago are now not so active. Copper buying comes in waves, and an ebb is taking place from the last one. These waves, however, work neither to the interest of the producer nor to that of the consumer. The movements in the lead market are in striking contrast to those of copper. Since last September lead has been practically stabilized at a 4.70c. level, whereas copper has moved sharply up and down. Of course, in the lead market buying has also been uniform and conducive to this stability; buying of copper has come in flurries.

ACTIVE COMPETITION FROM ALUMINUM WIRE MANUFACTURERS

This journal has frequently pointed out the danger that faces copper in possible competition with aluminum owing to the low prices for which aluminum has lately been selling. Tangible evidence is reported that this competition has assumed serious proportions. One copper-wire manufacturer maintains that he has lost five million dollars' worth of high-tension transmission wire business to aluminum-wire manufacturers who hopelessly underbid him. Aluminum has been successfully used in high-tension electrical transmission, and competition in this field is largely a matter of the relative prices of the two metals. Although for the same cross-section copper is a superior conductor of electricity, weight for weight the advantage lies with aluminum when roughly, the price of copper is more than half that of aluminum. However, other factors have to be considered, such as the longer span lengths that can be used for copper and the consequent saving in the cost of constructing towers. Nevertheless, with the present spread between the price of aluminum and copper, the former metal is a heavy favorite. The relation is shown as follows:

	Present Price of Ingots	Present Wire Prices
Copper	13.25c.	14.50@14.75c.
Aluminum	17.50c.	18.75@19c., est.

It is difficult to obtain a satisfactory open market quotation for aluminum wire. Much depends upon the particular lot desired. If the assumption is made, as in the quotation above given, that the same spread exists between aluminum ingots and aluminum wire as exists between copper ingots and copper wire, then it is likely that aluminum transmission business can be taken at 20c. per lb. Copper ingots to compete would have to sell at less than 10c. Fortunately, high-tension transmission line business is only a fraction of the electrical field. There are many uses of copper in machines with which no other metal has been able to compete. Then there is the great field of alloys, brass, and bronze, that takes great amounts of copper each year. But all prospective business taken from the copper producer at this time detracts from the speedy recovery of the market.

MEDIOCRE EXPORT BUSINESS

Another factor contributing to the present decline in copper is the falling off in foreign buying. The recent rise may have discouraged European buying, and it is altogether likely that the labor troubles in Germany have been a contributing cause to the falling off in export demand. The London market has dropped with that in New York.

Looking back upon the market for the last few weeks, it is easy to conclude that the recent advance was too sharp, and that a slower advance to a lower height which could have been sustained would have been more satisfactory. Possibly this circumstance will serve as an indication that a full recovery will have to feel its way gradually and will be much more prolonged than has generally been anticipated.

MINING STOCKS

Week Ended February 11, 1922

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	62½	61	62½	Sept. '20, Q	$0.50
Alaska-Br. Col. new.	N. Y. Curb	3	2⅞	2⅞	.....	.....
Allouez	Boston	29	28¼	28½	Mar. '19	1.00
Anaconda	New York	49⅛	47⅛	47⅛	Nov. '20, Q	1.00
Arcadian Consol.	Boston	2⅞	2¼	2¼	.....	.....
Ariz. Com'l	Boston	9⅜	8¾	8¾	Oct. '18, Q	0.50
Big Ledge	N. Y. Curb	*26	*22	*24	.....	.....
Bingham Mines	Boston	13½	13½	13½	Sept. '19, Q	0.25
Calumet & Arizona	Boston	59½	58½	58½	Dec. '21, Q	0.50
Calumet & Hecla	Boston	281	275	280	June '20, Q	5.00
Canada Copper	N. Y. Curb	*27	*26	*26	.....	.....
Centennial	Boston	12½	12	12	Dec. '18, SA	1.00
Cerro de Pasco	New York	34½	33½	33½	Mar. '21, Q	0.50
Chile Copper	New York	17¼	16	16½	.....	.....
Chino	New York	27	26	26	Sept. '20, Q	0.37½
Columbus Rexall	Salt Lake	*29½	*25	*25	.....	.....
Con. Arizona	N. Y. Curb	....	....	3	Dec. '18, Q	0.05
Con. Copper Mines	N. Y. Curb	1⅛	1⅛	1⅛	.....	.....
Copper Range	Boston	45	41½	42¼	Sept. '20, Q	0.50
Crystal Copper	Boston Curb	*61	*57	*58	.....	....
Davis-Daly	Boston	8⅛	7⅛	7⅛	Mar. '20, Q	0.25
East Butte	Boston	11⅛	10⅛	10⅛	Dec. '19, A	0.50
First National	Boston Curb	*70	*65	*65	Feb. '19, SA	0.15
Franklin	Boston	†1⅛	†1⅛	1⅛	.....	....
Gadsden Copper	Boston Curb	*50	*40	*50	.....	.....
Granby Consol.	New York	28⅛	27½	28⅛	May '19, Q	1.25
Greene-Cananea	New York	27⅞	27⅜	27⅜	Nov. '20, Q	0.50
Hancock	Boston	†2⅛	†2⅛	2⅛	.....	.....
Howe Sound	N. Y. Curb	2⅝	2½	2⅝	Jan. '21, Q	0.05
Inspiration Consol.	New York	39	37⅛	37⅛	Oct. '20, Q	1.00
Iron Cap	Boston Curb	*7	*7	*7	Sept. '20, K	0.25
Isle Royale	Boston	25⅛	24	24	Sept. '19, SA	0.50
Kennecott	New York	28⅛	26⅞	27½	Dec. '20, Q	0.50
Keweenaw	Boston	†1⅛	†1⅛	1	.....	....
Lake Copper	Boston	2½	2½	2½	.....	....
La Salle	Boston	2	1¾	2	.....	....
Magma Copper	N. Y. Curb	32½	30	30½	Jan. '19, Q	0.50
Majestic	Boston Curb	† 6	†*3	*3	.....	....
Mason Valley	Boston	†1⅛	†1⅛	1⅛	.....	....
Mass Consolidated	Boston	2⅛	2⅛	2⅛	Nov. '17, Q	1.00
Miami Copper	New York	26⅝	26⅛	26⅛	Nov. '21, Q	0.50
Michigan	Boston	†2⅛	†2	2⅛	.....	.....
Mohawk	Boston	57⅛	56	57	Nov. '20, Q	1.00
Mother Lode Coa.	N. Y. Curb	8¼	7⅞	8	.....	....
Nevada Consol.	New York	14⅛	13¼	13½	Sept. '20, Q	0.25
New Cornelia	Boston	18⅜	18	18½	Aug. '20, K	0.25
North Butte	Boston	12¼	11⅞	11⅞	Oct. '18, Q	0.25
North Lake	Boston	....	....	*25	.....	....
Ohio Copper	N. Y. Curb	*10	*10	*10	.....	.....
Old Dominion	Boston	25	24	24	Dec. '18, Q	1.00
Osceola	Boston	34	32	32	June '20, Q	0.50
Phelps Dodge	Open Mar.	†190	†175	...	Jan. '22, Q	1.00
Quincy	Boston	43	42	42	Mar. '20, Q	1.00
Ray Consolidated	New York	14⅛	13⅜	13⅜	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	*4	*2	*3	.....	....
St. Mary's Min. Ld.	Boston	46½	44	44	Dec. '21, K	1.00
Seneca Copper	Boston	...	...	16¾	.....	.....
Shannon	Boston	1	1	1	Nov. '17, Q	0.25
Shattuck Arizona	New York	8	8	8	Jan. '20, Q	0.25
South Lake	Boston	*65	*65	*65	.....	....
Superior & Boston	Boston	1⅛	1	1⅛	.....	....
Tenn. C. & C. cfs	New York	11⅛	10⅛	10½	May '18, I	1.00
Tuolumne	Boston	*65	*60	*60	May '13,	0.10
United Verde Ex.	Boston Curb	29½	28½	29	Feb. '22, Q	0.25
Utah Consol.	Boston	2¼	2	2¼	Sept. '18,	0.25
Utah Copper	New York	63⅜	60⅜	61½	Dec. '21, Q	0.50
Utah Metal & T.	Boston	1⅛	1⅛	1⅛	Dec. '17,	0.30
Victoria	Boston	2⅛	2	2 3/16	.....	....
Winona	Boston	¼	⅛	⅛	.....	....
Wolverine	Boston	10½	10	10⅜	.....	....
NICKEL-COPPER						
Internat. Nickel	New York	12⅞	12¼	12½	Mar. '19,	0.50
Internat. Nickel, pfd	New York	69¾	68¼	69¼	Nov. '21, Q	1.50
LEAD						
National Lead	New York	92	88½	88⅞	Dec. '21, Q	1.50
National Lead, pfd.	New York	112	112	112	Dec. '21, Q	1.75
St. Jose h Lead	New York	14¼	13¾	13¾	Dec. '21, Q	0.25
QUICKSILVER						
New Idria	Boston	†1⅛	75	1	.....	....
ZINC						
Am. Z. L. & S.	New York	13⅜	13	13⅜	May '20,	1.00
Am. Z. L. & S. pfd.	New York	13½	13	13½	Nov. '20, Q	1.50
Butte C. & Z.	New York	6	5⅜	5⅜	June '18,	0.50
Butte & Superior	New York	28¼	25½	25⅝	Sept. '20,	1.25
Callahan Zn-Ld	New York	5¼	5⅜	5⅜	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	136	133⅜	156	Feb. '22, Q	2.00
Yellow Pine	Los Angeles	...	...	*50	Sept. '20, Q	0.03

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	⅜	⅜	⅜	.....	....
Alaska Juneau	New York	⅛	⅛	⅛	.....	....
Carson Hill	New York	15⅞	13⅞	15	.....	.....
Cresson Consol. G.	N. Y. Curb	2 1/16	2⅛	2⅛	Jan. '22, Q	$0.10
Dome Extension	Toronto	*80	*80	*80	.....	.....
Dome Mines	New York	23¼	22⅜	23⅜	Jan. '22, Q	0.25
Florence Goldfield	N. Y. Curb	*23	*20	*22	.....	.....
Golden Cycle	Colo. Springs	*51	*51	*51	June '21, Q	0.02
Goldfield Consol.	N. Y. Curb	....	....	*4	Dec. '19,	0.05
Hollinger Consol.	Toronto	8.53	8.41	8.50	Jan. '22,	0.05
Homestake Mining	New York	†69½	†57	57	Jan '22, M	0.25
Kirkland Lake	Toronto	*32½	*30	*30⅜	.....	.....
Lake Shore	Toronto	1.47	1.44	1.44	Nov. '21, K	0.02
McIntyre-Porcupine	Toronto	2.55	2.44	2.55	Jan. '22, K	0.05
Porcupine Crown	Toronto	*19½	*16	*19	July '17,	0.03
Porcupine V. N. T.	Toronto	*23½	*20	*23½	.....	.....
Portland	Colo. Springs	*39	*38	*39	Oct. '20, Q	0.01
Schumacher	Toronto	*36½	*34	*36	.....	....
Silver Pick	N. Y. Curb	*2	*2	*2	.....	....
Teck Hughes	Toronto	*30	*29	*29⅜	.....	.....
Tom Reed	Los Angeles	*80	*70	*80	Dec. '19,	0.02
United Eastern	N. Y. Curb	2¼	2	2	Jan. '22, Q	0.15
Vindicator Consol.	Colo. Springs	*22	*22	*22	Jan. '20, Q	0.01
White Caps Mining	N. Y. Curb	*3	*3	*3	.....	.....
Yukon Gold	N. Y. Curb	1¼	1⅛	1⅛	June '18,	0.02½
SILVER						
Batopilas Mining	New York	†⅜	†⅛	†⅛	Dec. '07, I	0.12½
Beaver Consol.	Toronto	*21	*19½	*20	May '20, K	0.03
Coniagas	Totonto	1.25	1.00	1.00	May '21, Q	0.12½
Crown Reserve	Toronto	*15	*12¾	*15	Jan. '17,	0.05
Kerr Lake	N. Y. Curb	3⅜	3⅛	3⅜	Jan. '22, Q	0.12½
La Rose	Toronto	*40	*34½	*36	Apr. '18,	0.02
McKinley-Dar.-Sav.	Toronto	*18½	*17	*18	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	1.20	1.10	1.13	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6⅜	5⅛	5⅛	Jan. '22, Q	0.15
Ontario Silver	New York	5	4⅜	5	Jan. '19, Q	0.50
Ophir Silver	N. Y. Curb	....	....	*12	Jan. '12,	0.10
Temiskaming	Toronto	*34	*32	*34	Jan. '20, K	0.04
Trethewey	Toronto	*5½	*4	*4½	Jan. '19,	0.05
GOLD AND SILVER						
Boston & Montana	N. Y. Curb	*51	*45	*46	.....	....
Cash Boy	N. Y. Curb	...	...	*5	.....	....
Dolores Esperanza	N. Y. Curb	1⅛	1	1⅛	.....	....
El Salvador	N. Y. Curb	*4	*4	*4	.....	.....
Jim Butler	N. Y. Curb	*6	*6	*6	Aug. '18, SA	0.07
Jumbo Extension	N. Y. Curb	*4	*4	*4	June '16,	0.05
MacNamara M.&M.	N. Y. Curb	*7	*6	*6	May '10,	0.02½
Tonopah-Belmont	N. Y. Curb	1⅛	1 1/16	1⅛	Jan. '22, Q	0.05
Tonopah-Divide	N. Y. Curb	*65	*50	*61	.....	.....
Tonopah-Extension	N. Y. Curb	1 1/16	1⅛	1⅛	Jan. '22, Q	0.05
Tonopah Mining	N. Y. Curb	...	...	1	Oct. '21, SA	0.05
West End Consol.	N. Y. Curb	*73	*73	*73	Dec. '19, SA	0.05
SILVER-LEAD						
Caledonia	N. Y. Curb	*6	*5	*5	Jan. '21, M	0.01
Cardiff M. & M.	Salt Lake	1.07½	1.02½	1.07½	Dec. '20,	0.15
Chief Consol.	Boston Curb	3⅜	3⅛	3⅜	Aug. '21, Q	0.05
Consol. M. & S.	Montreal	19¼	18¾	19	Oct. '20, Q	0.62½
Daly Mining	Salt Lake	†2.50	†1.00	...	July '20, Q	0.13
Daly-West	Boston	2½	1⅞	2	Dec. '20, Q	0.25
Eagle & Blue Bell	Boston Curb	2 9/16	2½	2 9/16	Apr. '21, K	0.05
Electric Point	Spokane	*5	*4⅝	*5	May '20, SA	0.03
Federal M. & S.	New York	†12	†7	...	Jan. '09,	1.50
Federal M. & S., pfd	New York	40⅜	38⅜	38½	Dec. '21, Q	1.00
Florence Silver	Spokane	*19	*18	*19	Apr. '19,	0.01½
Grand Central	Salt Lake	*41½	*40	*40½	Jan. '21, K	0.01
Hecla Mining	N. Y. Curb	5¼	4 15/16	5	Dec. '21, Q	0.17
Iron Blossom Con.	N. Y. Curb	*19	*18	*19	Dec. '21, Q	0.02½
Judge M. & S.	Salt Lake	3	3	3	Sept. '20, Q	0.12½
Marsh Mines	N. Y. Curb	....	....	*4	June '21, I	0.02
Prince Consol.	Salt Lake	*8	*7½	*7½	Nov. '17,	0.02½
Rambler-Cariboo	Spokane	*5⅜	*5	*5¾	Feb. '19,	0.01
Rex Consol.	N. Y. Curb	*7	*6	*6	.....	.....
South Hecla	Salt Lake	†*60	†*35	...	Sept. '19, K	0.15
Standard Silver-Ld.	N. Y. Curb	*12	*10	*12	Oct. '17,	0.05
Stewart Mines	N. Y. Curb	*3	*3	*3	Dec. '15,	0.05
Tamarack-Custer	Spokane	1.75	1.75	1.75	Jan. '21, K	0.04
Tintic Standard	Salt Lake	2.20	2.07	2.10	Dec. '21, Q	0.05
Utah Apex	Boston	3⅛	2⅞	3	Nov. '20, K	0.25
Wilbert Mining	N. Y. Curb	....	....	*1	Nov. '17,	0.01
VANADIUM						
Vanadium Corp.	New York	35⅞	33½	34	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp	Montreal	48½	44	45½	Jan. '22, Q	1.50
Asbestos Corp., pfd.	Montreal	....	....	78	Jan. '22, Q	1.75
SULPHUR						
Freeport, Texas	New York	14½	13½	13⅜	Nov. '19, Q	1.00
Texas Gulf	New York	45½	42	42½	Dec. '21, Q	1.00
MINING, SMELTING AND REFINING						
Amer. Sm. & Ref.	New York	46¾	45½	45½	Mar. '21, Q	1.00
Amer. Sm.& Ref. pf.	New York	91	90	91	Dec. '21, Q	1.75½
Am. Sm. pf. A	New York	87	87	87	Jan. '22, Q	1.50
U. S. Sm. R. & M.	New York	35	32⅜	32⅜	Jan. '21, Q	0.50
U.S. Sm.R.& M. pf.	New York	43½	42½	43½	Jan. '22, Q	0.87

*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Hamilton B. Wills; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Commerce and Oil; Colorado Springs, The Financial Press, N. Y.